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December 1945

TECHNOLOGY REVIEW

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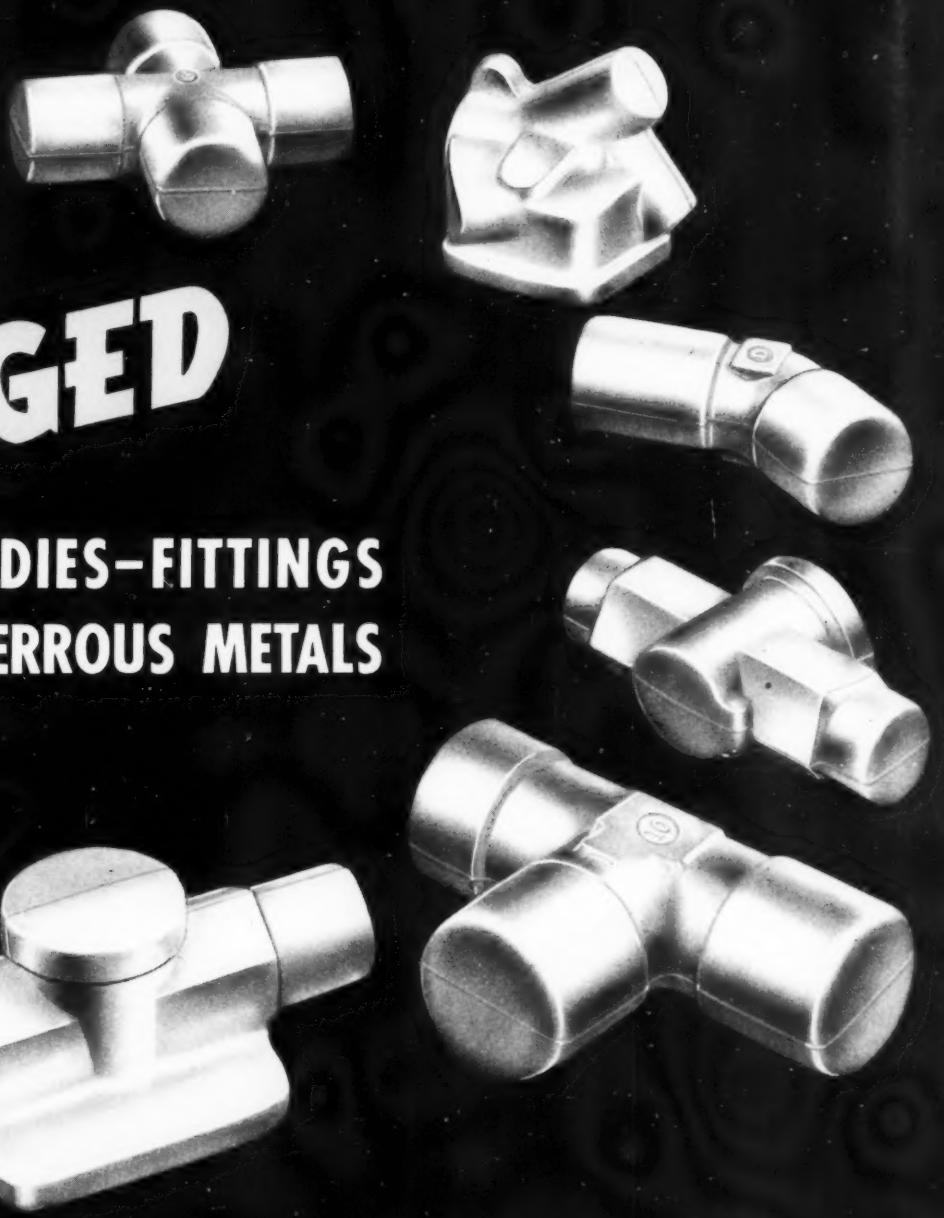

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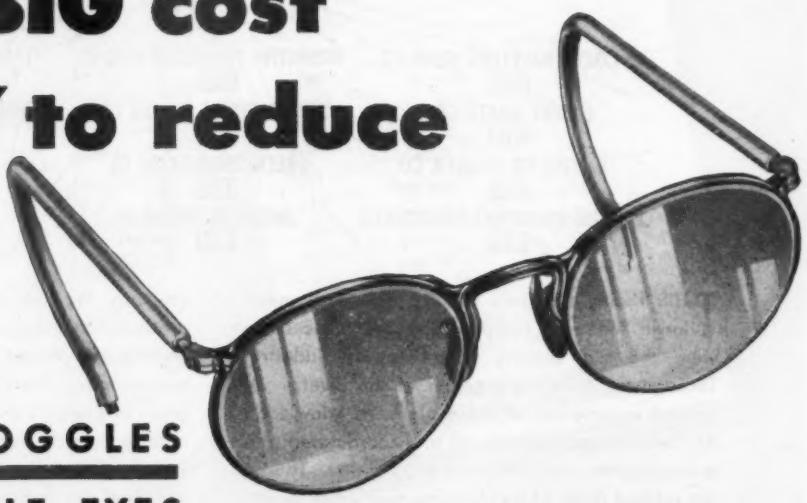

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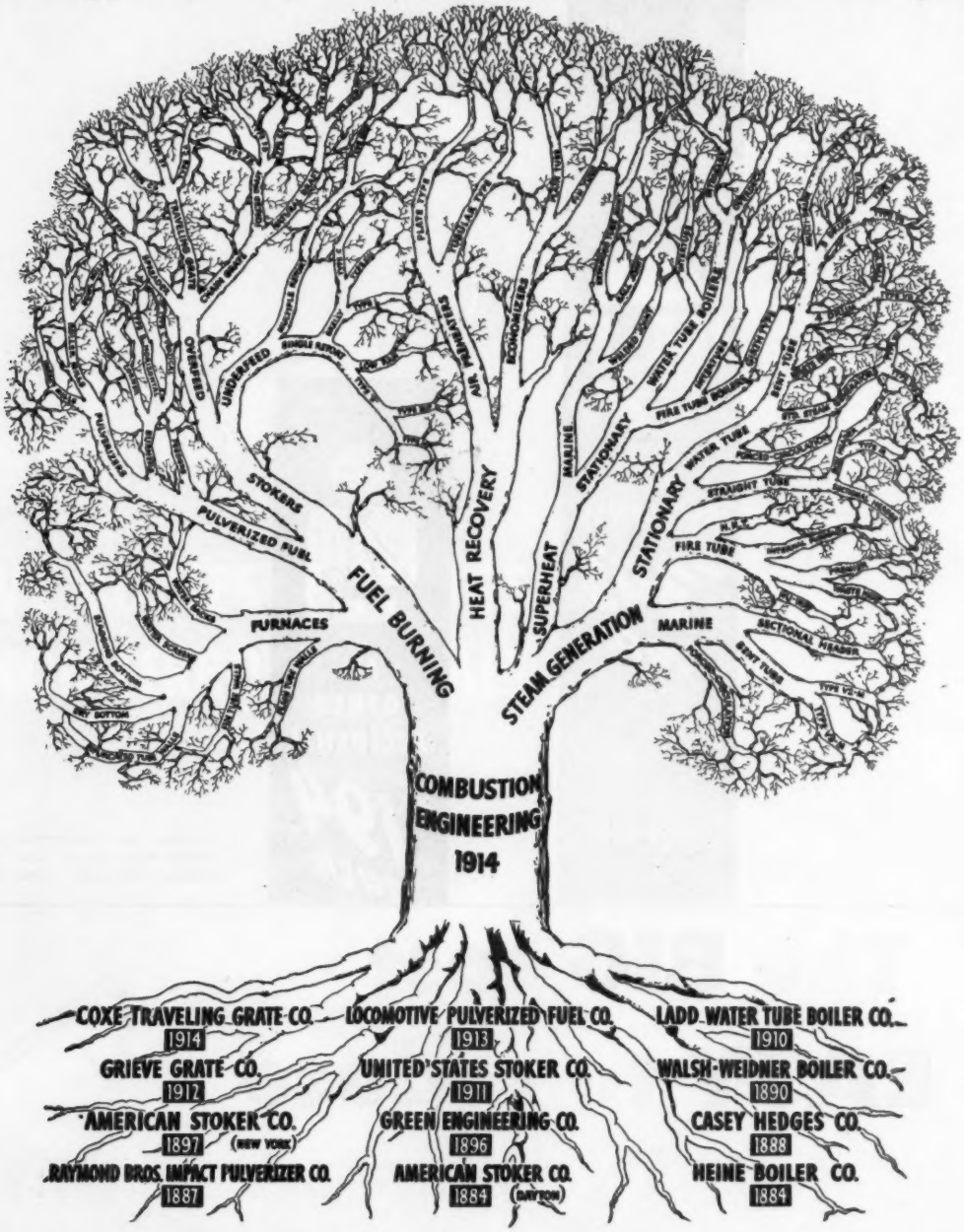
A genealogy that has contributed much to industrial progress



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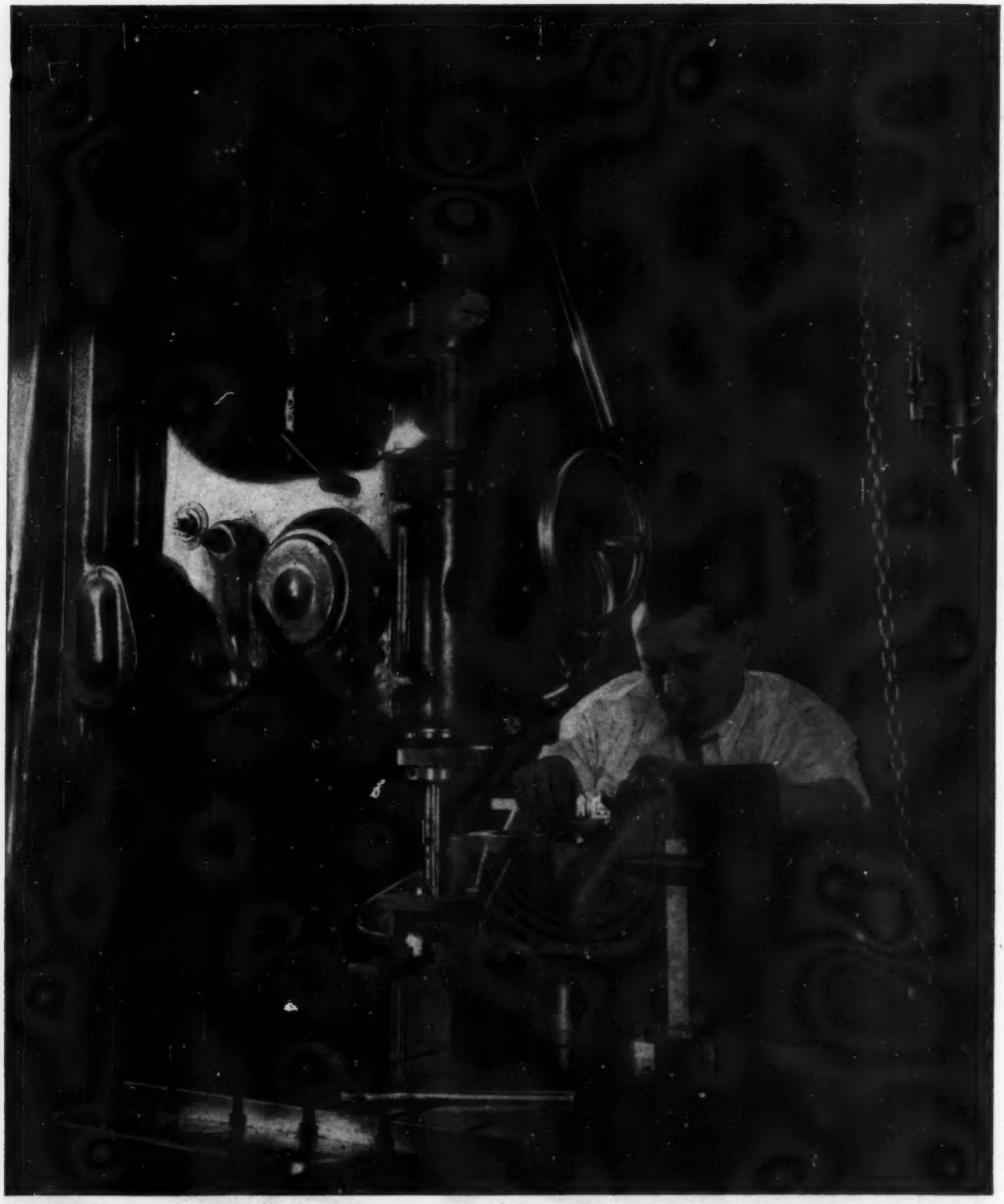

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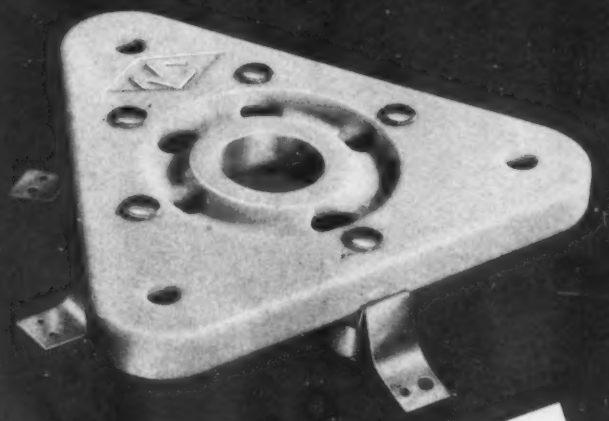

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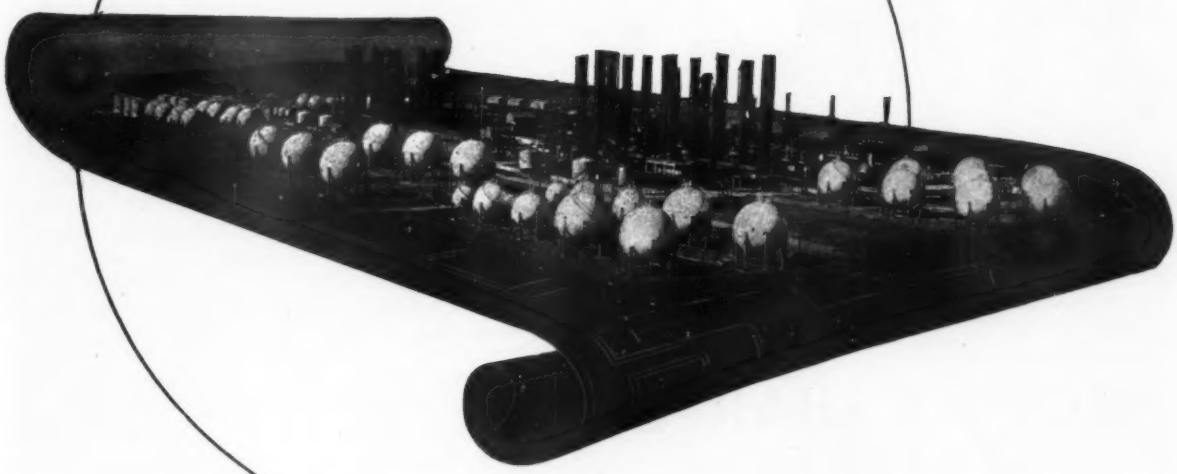

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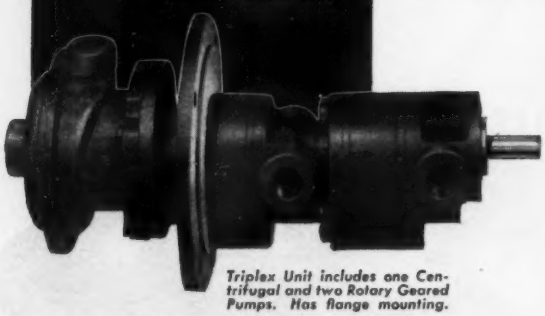

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THE TECHNOLOGY REVIEW
Cambridge 39, Mass.

THE TABULAR VIEW

Pioneers. — Among the earliest efforts in airplane instrumentation are the tests of the late Professor Alfred V. de Forest and Captain Luis de Florez, who received their degrees in 1912 but affiliated with the Class of 1911. Working together on their undergraduate thesis, "Tests on a Burgess-Wright Aeroplane," these two young men made what is believed to be the first measurements of the thrust of an airplane propeller in flight.

The importance of their 1912 undergraduate thesis is reviewed (page 96) by PROFESSOR JEROME C. HUNSAKER, '12, himself a noted pioneer in aviation, as attested by the award made to him in 1933 of the Daniel Guggenheim Medal for achievement in aeronautics and by the title of his doctoral thesis, "Dynamic Stability of Aeroplanes." After spending 18 years as an officer in the Navy, two years as vice-president of the Bell Telephone Laboratories, and five years as vice-president of the Goodyear-Zeppelin Corporation, Dr. Hunsaker returned to the Institute in 1933 and now heads the Departments of Mechanical and Aeronautical Engineering.

Survey. To the long list of his articles, PRESIDENT KARL T. COMPTON has added "Mission to Tokyo," and The Review is happy to present (page 99) this report, which resulted from his active participation in scientific projects aimed to win the peace.

Granted six months' leave of absence to direct the activities of several hundred scientists in the Pacific in the war against Japan, President Compton left Cambridge for Manila late in July. Six days after he reached Manila and began organizing this scientific staff, the Japanese had negotiated for surrender. Instead of being free to return to the Institute, Dr. Compton was confronted with a new and unexpected assignment in which the war research projects and scientific resources of Japan were to be surveyed as quickly as possible as one phase of the early occupation of the Japanese islands.

(*Concluded on page 90*)

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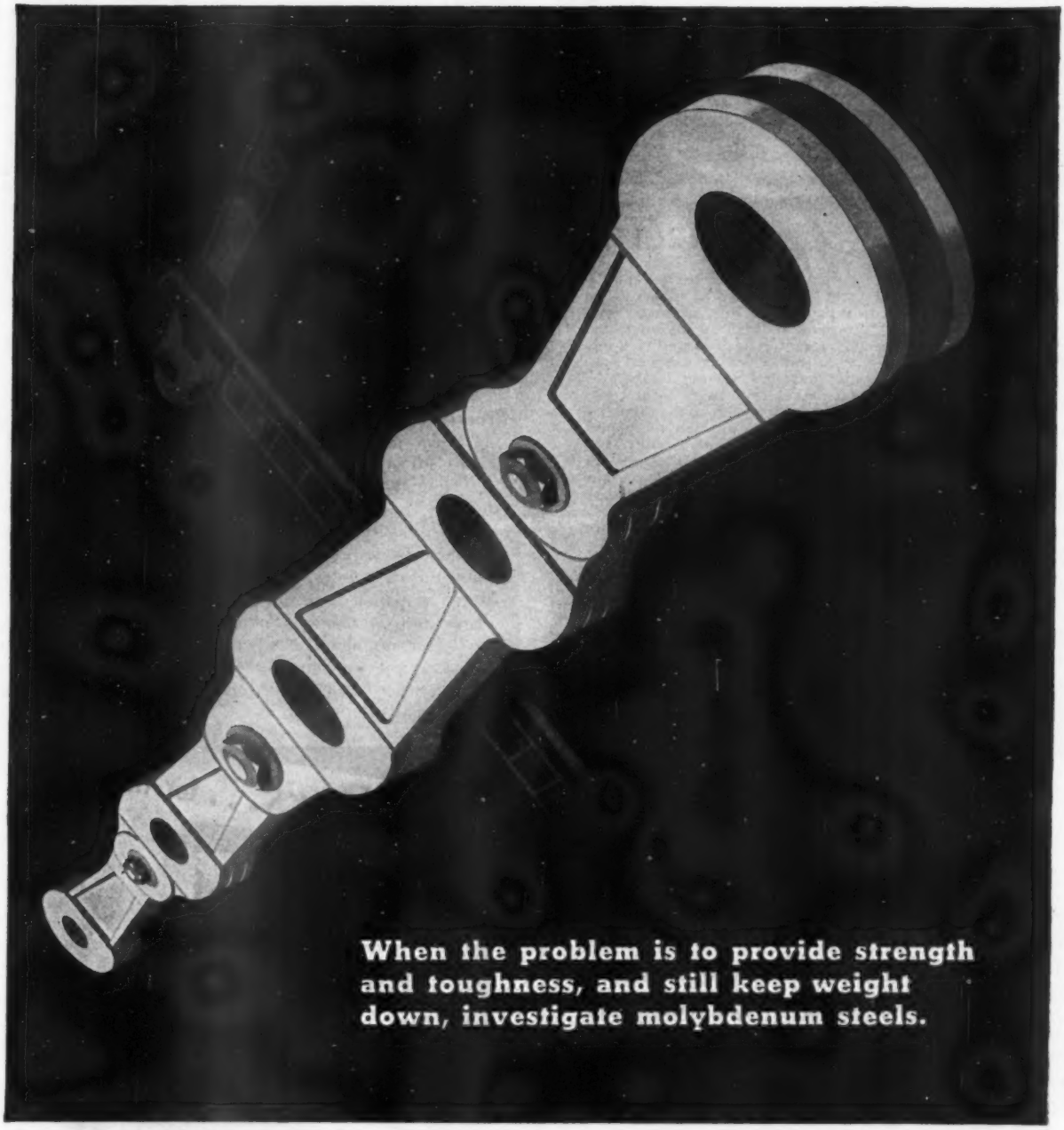

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THE TABULAR VIEW

(*Concluded from page 88*)

Acquisition. — Significant work carried on at the Development Laboratory of the Chemical Warfare Service between 1942 and 1945 is ably recorded (page 103) by FREDERICK W. HOLT, JR., '30, who, as an Army captain, was engaged in development projects at the laboratory until the spring of this year when he became public relations officer. Mr. Holt has recently returned to civilian life, and he is now engaged in chemical research at the Institute for his company, the Brown-Bridge Mills, of Troy, Ohio, where he is technical director.

Practicality. — Having observed scientists at work during the war, PROFESSOR PHILIP M. MORSE, of the Institute's Department of Physics, explodes (page 107) the popular misconception that men of science, particularly those in academic pursuits, are completely out of touch with practical problems. Author of more than 30 scientific papers, largely in the fields of acoustics, quantum mechanics, and nuclear physics, Professor Morse also has two full-length books to his credit. These are *Vibration and Sound* and *Quantum Mechanics*, the latter of which was written in joint authorship with Edward U. Condon, formerly of Princeton University, where Professor Morse studied before coming to the Institute.

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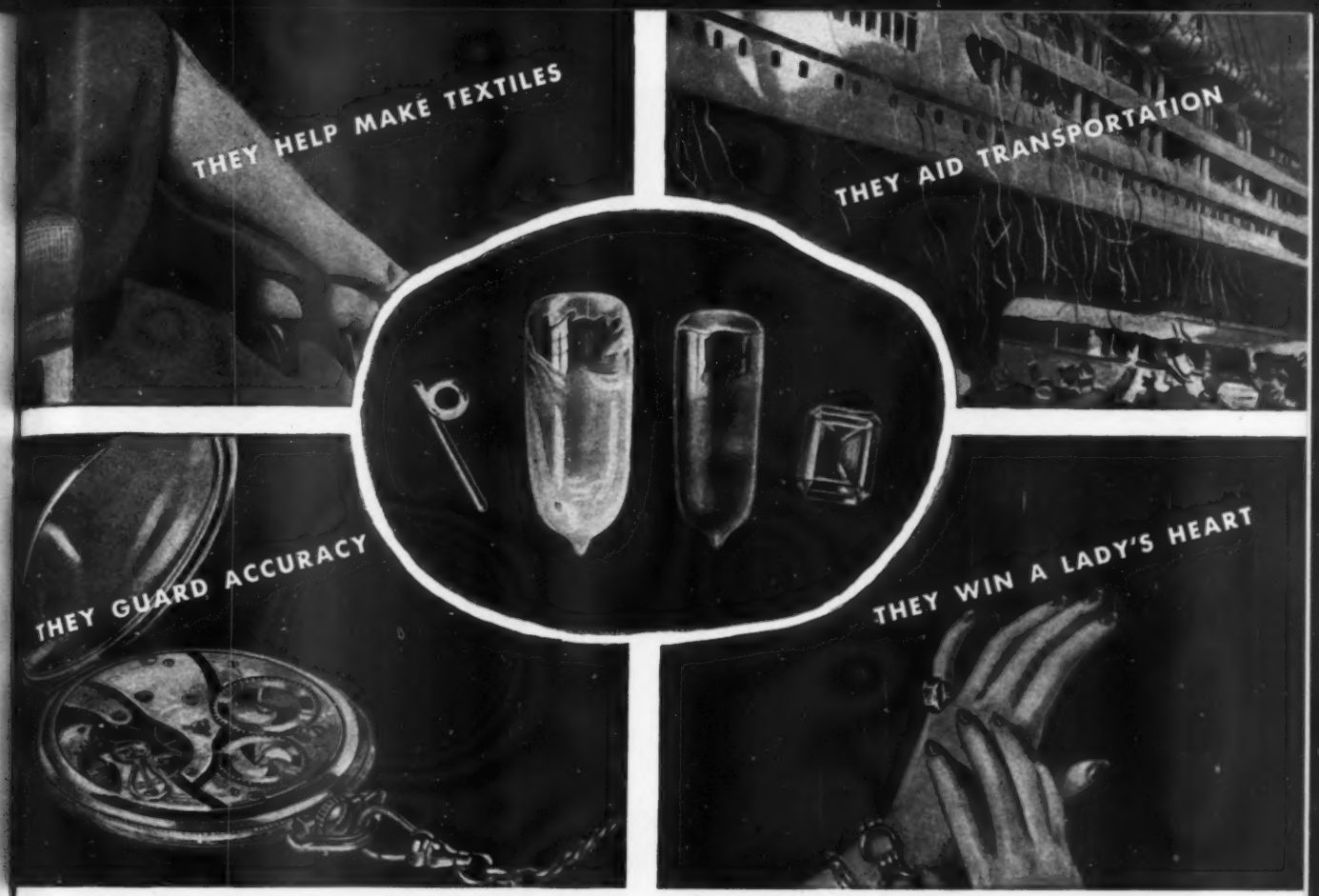

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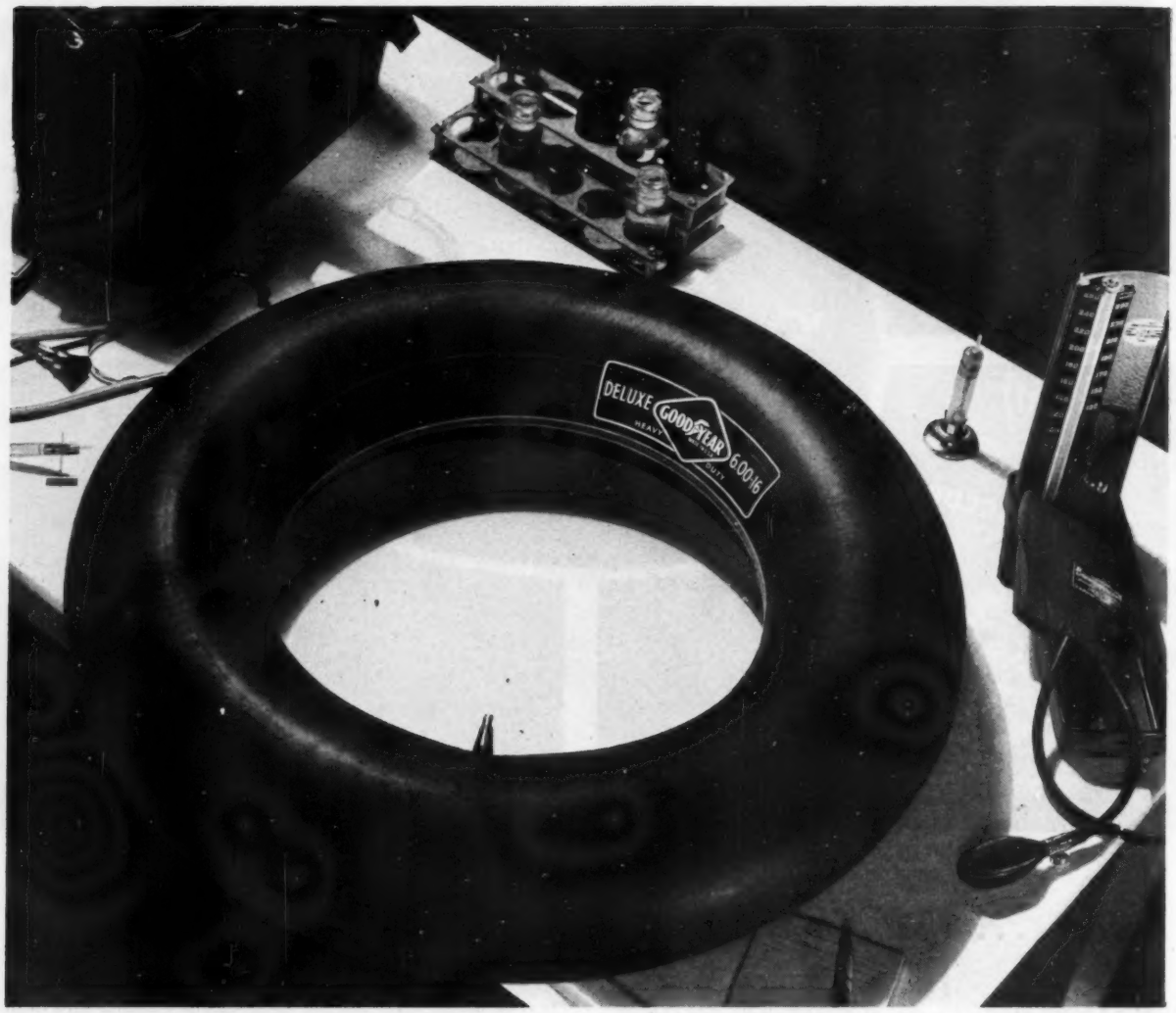

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VOLUME 48 NUMBER 2

THE TECHNOLOGY REVIEW

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AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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FALL LEAVES

THE
TECHNOLOGY
REVIEW

Vol. 48, No. 2 December, 1945

The Trend of Affairs

Gold and Silver Anniversaries

ANNIVERSARIES of two scientific and engineering achievements which have profoundly changed our mode of living are celebrated this month. The oldest of these is the discovery of x-rays late in 1895 by Dr. Wilhelm Konrad Roentgen, professor of physics at the University of Wurzburg in Bavaria; the second is the inauguration of regular radio broadcast programs on a practical scale by station KDKA in Pittsburgh. Radiography thus celebrates its golden anniversary and radio broadcasting can boast of 25 years of continuous service.

At the December meeting of the Wurzburg Physico-Medical Society, Roentgen modestly announced his discovery of a new and unknown type of radiation. The news of the discovery of x-rays spread rapidly, and within a short time physicists all over the world were investigating the new rays produced by Crookes tubes, one of which Roentgen was using on November 8, 1895, when he observed the effects of x-rays more or less accidentally. The tube which Roentgen used had been covered with black paper, and, in the darkened laboratory, Roentgen observed a brightly glowing screen of barium platinocyanide which lay a short distance from the tube. The glow was observed even when the screen was removed a distance of a meter or two from the tube, and it was immediately and correctly ascribed to a new and unknown type of radiation.

The discovery of x-rays came at a time when it was more or less generally believed that all the important scientific discoveries had been made and that the physicists' work in the future would be principally that of refining existing knowledge and making more precise measurements of already known phenomena. Following by eight years Hertz's discovery of the existence of electromagnetic waves (which had been predicted in 1864 by Maxwell on the basis of purely mathematical reasoning), Roentgen's discovery of the new form of radiation greatly disturbed the complacency of late Nineteenth Century scientists.

Most startling characteristic of the newly discovered radiations was their ability to penetrate objects which were opaque to ordinary light. One of the earliest radiographs made, that of Frau Roentgen's hand, with wedding ring and bones clearly visible, was an unmistakable signal to medical men that the new discovery had important applications in medicine. The applications of radiography are no longer limited to medicine, for they have grown by leaps and bounds. By making use of the differential absorption of x-rays, radiography is used for the photographic and visual diagnosis of disease or the location of broken bones or foreign particles in the human body. The same characteristics are employed in the x-ray examination of old paintings and in industrial radiography for testing homogeneity and soundness of welds and castings. The lethal effect of x-rays on abnormal cells has led to the treatment of cancer. By making use of the scattering and characteristic absorption and emission of x-rays, spectroscopy has employed x-rays for the identification of chemical elements, for examination of atomic structure, and for studies in the development of the quantum theory. In radiobiology, cells and tissues have been identified by the specific sensitivity of the cells and tissues to radiographic radiation. Fine structure of materials has been investigated in x-ray crystallography and crystal chemistry by making use of the diffractions of x-rays produced by the crystals. Truly Roentgen's "chance" observation helped to produce a world-wide revolution in thinking.

Another revolution, but of a different kind, was inaugurated 25 years ago when regular evening radio programs were initiated from station KDKA on December 1, 1920. In a certain sense, radio broadcasting, like the discovery of x-rays, may be said to be more or less accidental. Certainly it was accidental in the sense that Frank Conrad, who owned and operated station 8ZZ, the predecessor of KDKA, did not originally set out to establish a broadcasting system. He was, instead, much more interested in the accuracy of watches and other timepieces.

Mr. Conrad's interest in radio began with his desire to receive time signals transmitted by NAA at Arlington, Va., and one or two other stations providing this service shortly after World War I. Having built receiving equipment, Mr. Conrad's attention was next turned to radio transmission, and he built and operated in his own home one of the first amateur radio telephone stations in this country. Occasionally phonograph records were played for a handful of listeners who, like Conrad, had built their own amateur radio stations. The successful operation of 8ZZ ultimately resulted in the establishment of KDKA by Mr. Conrad's company, which had been engaged in making radio apparatus during World War I.

KDKA was placed in operation on November 2, 1920, and broadcast as its first program the presidential election returns of that date. Semiweekly programs were put on from that date until December 1, when regular nightly programs were commenced. Within two years' time great activity had developed in the building of home receivers, and by 1925 the beginnings of the radio industry had already been established. The Federal Radio Commission (now the Federal Communications Commission) was organized in 1927 to bring order out of the chaos which resulted when hundreds of radio stations attempted to operate simultaneously on nearly the same frequency. Radio networks soon followed. Radio communication has grown so rapidly and soundly that we seldom realize that 15 years ago transatlantic communication by voice was still regarded with awe.

In these days of enthusiastic cacophony and soapbox operas it is pleasant to recall that a serious attempt was made in some of the earliest radio programs to provide the best music available at the time. Well-known musicians of the early Twenties performed on the air, and the Chicago Civic Opera had as a regular feature the radio transmission of their Saturday afternoon programs.

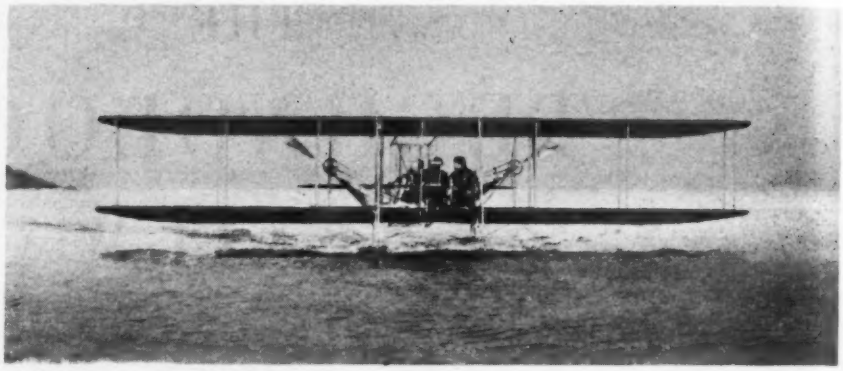
Neither Roentgen nor Conrad alone was responsible for our present use of x-rays and broadcasting, for many others have also made substantial contributions to these two fields. But their work was responsible for initiating new eras which have benefited man.

Propeller Thrust—1912

By Jerome C. Hunsaker

PROGRESS in aviation has been so rapid that it is easy to lose sight of early developments. The unusual 1912 thesis by the late Alfred V. de Forest and his partner Luis de Florez, both graduates of the Institute Class of 1912,[1] describes, so far as I can learn, the very first measurement of the thrust of an airplane propeller in flight. It has, however, a broader interest in that it appears to forecast very distinguished work for both De Forest and De Florez in the field of instrumentation for special engineering purposes.

[1] Professor de Forest and Captain de Florez later affiliated with the Class of 1911.



Photograph of the Burgess-Wright airplane of 1912 on which were installed the instruments for making measurements of propeller thrust. The photograph is from the thesis, "Tests on a Burgess-Wright Aeroplane," by the late Alfred V. de Forest, '11, and Luis de Florez, '11.

In their thesis, "Tests on a Burgess-Wright Aeroplane," the authors reported on the measurement of the thrust in flight of one of the twin propellers of a Wright biplane, mounted on floats and known as a Burgess-Wright. Before 1912 there had been extensive testing of airplane propellers to determine the static thrust when the airplane was held on the ground, but the thrust in flight was only estimated by a crude rule.

De Forest and De Florez undertook to design, build, calibrate, and test an apparatus to measure the thrust of the propeller and the revolutions of the engine and to record these measurements continuously on a moving paper bearing a time record.

A very small motion of the thrust bearing was taken up against thin copper diaphragms closing the ends of a pair of oil-filled steel cups. In this manner the thrust was transmitted to the oil and thence by copper tubing to a standard 60-pound steam pressure gauge. The thrust record was made on the paper of the recorder by the brass point of a straight-line indicator motion, multiplied two to one by a small lever pivoted to the Bourdon tube of the gauge. Displacement of the record line from a base line measured the thrust.

An ingenious artifice, perhaps an invention, was provided to adjust the zero thrust reading to the base line. In addition to the tube to the pressure gauge, a short, soft metal tube was connected to the cups by which they could be filled. After having been filled, the open end of the filling tube was crushed and sealed off with solder. By still further crushing the sealed filling tube, the capacity of the oil system could be reduced and an initial pressure put upon the gauge. The distorted filling tube was referred to by interested bystanders at the time as a "dufingleoid."

The system was filled by exhausting the air with a vacuum pump, allowing oil to take its place. Calibration of the scale of the thrust indication was accomplished by a spring balance and turnbuckle. Friction was eliminated by jarring the airplane to simulate conditions with engine running. The spring balance was calibrated at the M.I.T. mechanical laboratories on Trinity Place. The authors reported that they could read the record to within 1 per cent.

Revolutions were counted by driving the paper of the recording drum from the engine by means of a flexible shaft and suitable gearing. Half seconds were recorded on the same paper by an electromagnet and contact clock.

Speed was computed from elapsed flying time over a chosen course.

The airplane was underpowered or overloaded by the floats and could stay in the air only when the engine ran full out, and it could get into the air only on a calm day.

A trial course was laid out between Marblehead Harbor and Bowditch Ledge Beacon in Salem Bay. After a long wait, ideal conditions were had at sunrise on May 1. W. Starling Burgess, who owned the plane and took a sporting interest in the project, flew the plane, with De Forest as passenger to look after the recording apparatus. De Forest was chosen for the trials because he weighed less than De Florez.

The record from these trials, besides being the first of the kind ever made, so far as I know, is of interest in showing the extremely modest performance of one of the best airplanes of 1912. The tests gave the following typical results for one propeller:

Run	Speed M.P.H.	Engine R.P.M.	Propeller R.P.M.	Thrust Lbs.
Outward	41.5	1414	457.5	123.5
Inward	41.7	1499	485	127.5

The Wright airplane of the day had a single engine, driving two slow propellers by means of chains and sprockets. Consequently, the total propeller disk area was extremely large in proportion to the thrust delivered, and propeller efficiency was perhaps as great as 80 per cent.

The De Forest and De Florez measurement of 125.5 pounds thrust for each propeller at an airplane speed of 41.6 miles per hour corresponds to a total of about 28 thrust horsepower. For 80 per cent propeller efficiency and 95 per cent efficiency for the chain drive, the engine should have delivered about 35 brake horsepower. It is understood to have been rated at that horsepower, but it rarely delivered the expected output.

In retrospect it may be observed that the thesis by De Forest and De Florez gave early indication of the abilities of these men in the field of industrial instrumentation in which both were destined to make outstanding contributions. Professor de Forest profoundly affected testing and inspection methods throughout industry by the development of electric strain gauges, magnetic apparatus for testing steel, brittle lacquers to portray stress distribution, and fluorescent oil to reveal cracks in nonferrous materials. Captain de Florez, recently appointed assistant chief of the Navy's newly created Office of Research and Invention, has brought special instrumentation into engineering practice. His work has been especially notable in the control of operations in petroleum refining and more recently in aviation, gunnery, and navigation.

Theaters for Export

AMERICAN-MADE films have long been one of our most important export items. In normal times they are seen by most of the 200,000,000 people who form the world's weekly moving picture audienee. Although, as of the beginning of 1940, the United States possessed only about one-fifth of the world's moving-picture theaters, there are great areas where the ratio of theater seats to potential customers is far lower than in this country.

In a typically American reaction to this situation, a company has been organized by one of the major motion picture exhibitors to produce and sell complete, prefabricated theaters. Four basic models have been designed, ranging in capacity from 800 to 1,200 seats. While smaller communities in the United States are possible markets, the main interest is in South America. China and Russia are also considered capable of absorbing large numbers of such units, perhaps up to 20,000 theaters apiece. It has been estimated that, for overseas installations, the cost of producing, packaging, and shipping such theaters may run from 40 to 60 per cent less than for equivalent units built on the spot. The first of these prefabricated moving-picture houses was scheduled to open at North Long Beach, Calif., on Thanksgiving Day.

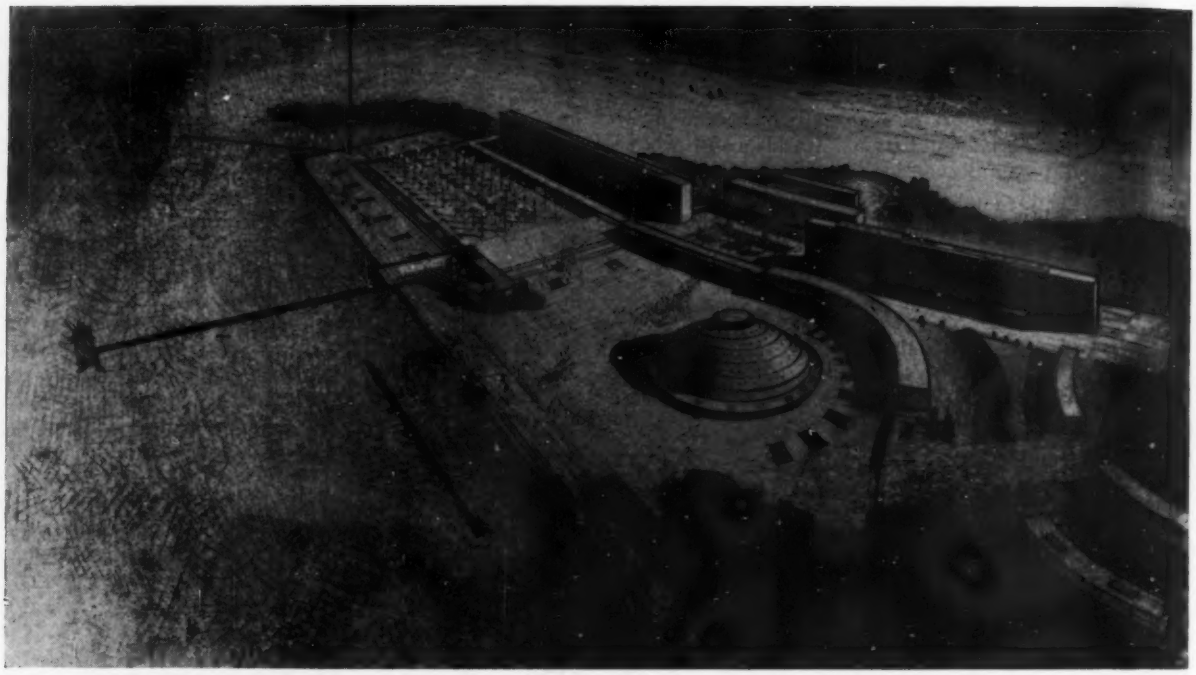
Much of the construction is of enameled sheet iron or of fireproof composition panels that snap into place. Even the aisle carpets are precut and ready to button to the floor. Only the concrete floor slab and the column footings are made on the spot. Heating, air-conditioning, and projection and sound equipment are all packaged ready for installation, in some cases requiring no more than being plugged into the nearest electrical receptacle for immediate operation. And, crowning touch, the towering theater sign can also be used as a television receiving antenna!

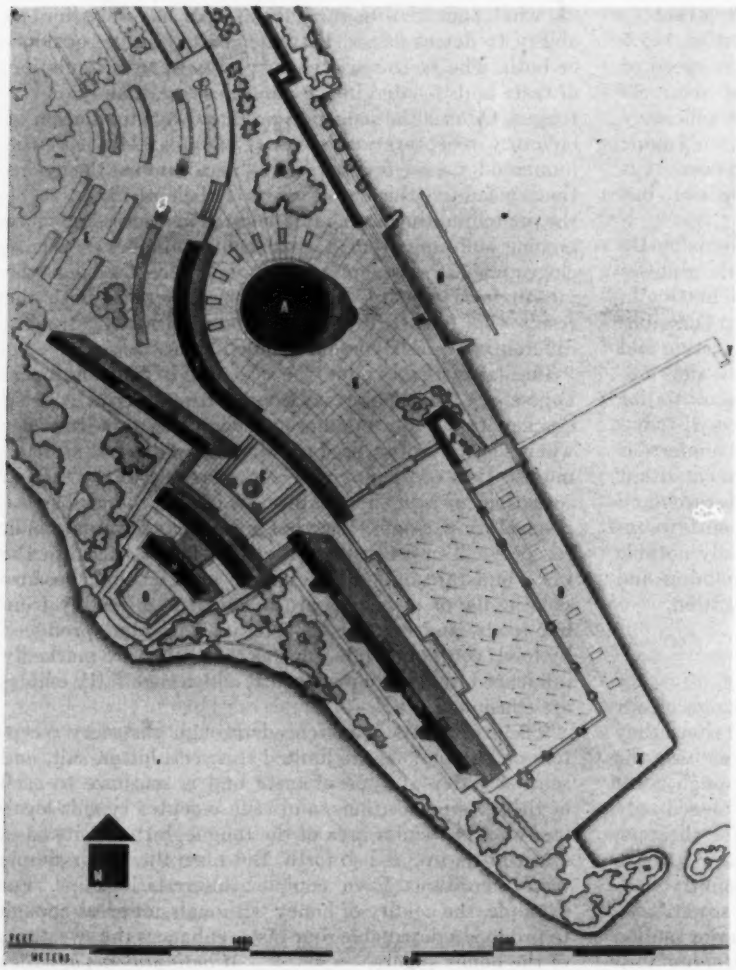
Good Taste

TO say that a favored food pleases the palate is somewhat figurative because that organ has only limited ability to detect flavor. Flavor consists of taste or odor, or both. The taste sensation is produced by stimulation of taste buds located in the mouth cavity, mainly on the tongue. Odor is the sensation produced by stimulation of olfactory receptors in the nasal cavities. Although the human odor sense degenerated as man climbed the evolutionary ladder, this sense is still sufficiently keen to be the predominating element of flavor. This fact is known to anyone suffering from a head cold or hayfever, whose clogged nasal passages prevent odors of foods in the mouth from reaching the olfactory receptors, with the result that some foods, which are normally strongly differentiated in flavor, taste much alike.

Besides taste and odor, the sensation of touch and perhaps also that of pain may contribute to flavor. A crisp cracker tastes quite different from the same cracker when soggy, simply because of tactile differences in the mouth. Part of the flavor of pepper is due to the tactual sensation, of a tickling nature, which it produces in the respiratory passages. Very hot spices may stimulate pain receptors. Temperature also affects flavors because the taste buds are dulled by extreme heat or cold, because volatile flavor principles are released more readily from hot foods, and because the tactual sensations produced by foods containing fats, such as rich soups, are markedly influenced by the temperature at which such fatty edibles are consumed.

The true tastes, experienced through gustatory receptors on the tongue, are limited to sweet, bitter, salt, and sour. A different type of taste bud is sensitive to each of these four sensations, and each receptor type is localized on a particular area of the tongue, bitter at its base, sweet at its tip, and so forth. But even these four simple taste sensations have complex interrelationships. For example, the acidity of honey, although not great enough to produce a detectable sour taste, enhances the sweetness of the honey sugars. *(Continued on page 132)*





United Nations Center

Suggestive of a suitable center for the United Nations Organization is an architectural plan utilizing the site of the World Conference, held in March in San Francisco Bay. Until a site for the new world organization has been chosen, proposals such as this one by William W. Wurster, Theodore C. Bernardi and Ernest Born, San Francisco architects, can be regarded only as representing possible architectural treatment. Professor Wurster is head of the Department of Architecture and Planning at the Institute.

Shown above is a general view of the main group of buildings, Entrance Court, Court of Flags, and Library Court, which are adapted to the use of Strawberry Point in San Francisco Bay. Access to this center could be by airplane, small sailing craft, or land transportation systems.

At the left is shown a plan view of the suggested development. The letters on this illustration represent the following: A, *Auditorium, seating 10,000 people;* B, *Archives Building, where documents of member governments are on file for official use;* C, *Library Court with revolving globe;* D, *Outdoor exhibits;* E, *Auxiliary buildings, housing scientific and study organizations;* F, *Court of Flags, where flags of member governments would be flown on state occasions;* G, *Entrance Court and Auditorium Plaza;* H, *Harbor for small craft;* L, *Library, for housing historical documents, open to the public;* M, *Museum;* O, *Outdoor museum;* P, *Press and Information Building;* R, *Restaurant, open to the public;* S, *Secretariats, housing offices of member governments;* U, *Underpass to parking areas;* X, *Beacon;* and Y, *Seaplane landing base.*

Mission to Tokyo

Large Factor in Japan's Defeat Was Her Unwillingness to Use Her Best Scientists Most Effectively in Positions of Trust

By Karl T. Compton

OUR mission to Tokyo came about much sooner than Edward L. Moreland, '07, Dean of Engineering at the Institute, or I ever imagined it would. In fact we had no idea that we would soon be in Tokyo when we were granted leaves of absence to go to Manila on different but related assignments.

Taken together, the tasks to which we were assigned represent the peak in the development of techniques for making scientists and engineers of greatest usefulness in the active theaters of military operations. These techniques were first employed in 1941 when the Office of Scientific Research and Development established a liaison office in London. Through this office, scientists in the United States and the United Kingdom could exchange information and assistance on problems on which they were working for the allied armed forces. Later, scientists and engineers who had worked on the development of new weapons in this country were sent to the London liaison office to give direct assistance to our own armed forces as these new weapons were put to use against the enemy. In the earliest stages this assistance sometimes went so far as to require scientifically trained personnel to operate the equipment against the enemy. The main task, however, was that of training military personnel in the maintenance and use of new equipment and, most important of all, of serving in an advisory capacity at staff level when new tactics based on recently devised weapons were being developed.

The most significant of the European scientific cooperative activities were those of the British Branch of the Radiation Laboratory for radar and the American-British Laboratory 15 for radar and radio countermeasures, operated respectively by the Institute and Harvard University under O.S.R.D. contract since 1943. The experience gained in Europe in co-ordinating the work of our scientists with the operations of our military leaders led to the development of equally effective liaison in the Pacific.

Based on European experiences, a plan was developed by General of the Army Douglas MacArthur and his chief of staff, Lieutenant General Richard K. Sutherland, which actually brought the civilian scientific experts into full partnership with the military. At the same time, it retained for them that degree of independence of action on technical matters which is so necessary for effective scientific work. My colleague in the Office of Field Service of O.S.R.D., Alan T. Waterman, associate professor of physics at Yale University, was of great assistance in the development of this plan for securing maximum military help from science in the active theater.

The Pacific plan can be most easily understood by explaining its relationship to the regular military organization. Under the commander in chief, General MacArthur, and reporting directly to his chief of staff, General Sutherland, are the staff, which may be divided into two groups — the general staff and the special staff. As usual, the general staff is composed of G1, personnel; G2, intelligence; G3, operations; and G4, supply. The special staff includes such officers as may be appointed by the commander in chief to meet the needs of his staff. In this case they included the chief signal officer, the chief engineer officer, the chief of antiaircraft, the chief of counterintelligence, and others. There was created a new special staff section called the scientific and technical advisory section, headed by Dean Moreland. Both general and special staffs have no direct operating responsibilities but serve in an advisory capacity to the chief of staff as he carries out the policies of the commander in chief. Dean Moreland's function was therefore to serve as special adviser to the chief of staff on general scientific and technical matters.

Also reporting to the commander in chief through his chief of staff are the various operating branches which, in this case, included the First, Sixth, and Tenth Armies, the Far Eastern Air Force, the Seventh Fleet, and the Army Service Forces of the Mid-Pacific and West-Pacific areas. To these branches was to be added a new operating organization known as the Pacific Branch of the Office of Scientific Research and Development. It was my initial mission to Manila to organize and head this new operating agency.

On all matters involving action, the Pacific Branch of O.S.R.D. (P.B.O.S.R.D.) was under the direct control of the commander in chief through his chief of staff, just like any operating military unit. But on all technical and administrative matters the Pacific Branch had free communications with the parent O.S.R.D. and its various divisions and contractors. Through the Office of Field Service and the contractors of O.S.R.D. the personnel and equipment needed for the Pacific job were secured. This project required several hundred engineers and technicians in addition to 300 tons of special laboratory and shop equipment which were being processed for initial shipment to Manila when the war ended.

Closely following the structure of the parent organization at home, the P.B.O.S.R.D. was divided into sections devoted to such matters as radar, countermeasures, rockets, special missions, pro- and antisubmarine tactics, fire control, chemical warfare, optical instruments, communications, and medicine. In all these fields the Pacific group had three functions: to provide expert advisory service, to supply skilled technicians and instructors, and, in its laboratory, to modify or construct equipment desired for use against special enemy objectives.

General MacArthur emphasized his desire to make the services of this P.B.O.S.R.D. freely available to any unit of the Army, Ground Forces, Air Forces, Service of Supply, or Navy, whether or not under his direct command. Arrangements had been effected thus to assist the Army

Strategic Air Force, under General Carl Spaatz, on Guam and Okinawa, while under the Armed Forces of the Pacific a branch unit was already operating under Lieutenant General Robert C. Richardson, Jr., on Hawaii, and small advanced parties were starting work for General George C. Kenney, '11, of the Far Eastern Air Force.

Thus the stage was well set for the military forces in the Pacific to utilize to the utmost the scientific forces of our country in the final all-out assault on Japan. The main resources would be initially supplied through the laboratories organized under O.S.R.D. back home. In Manila, the P.B.O.S.R.D. would provide the advanced echelon of scientific support. Each military organization operating in a forward area could draw on these sources for new-weapon specialists or tailor-made equipment for emergency use. When the war ended there were about 60 scientists at work in the Pacific on problems ranging from medicine to the atomic bomb. These men were just becoming co-ordinated under P.B.O.S.R.D., and some 200 more were scheduled for early arrival. In Manila, arrangements were made for a 20,000-square-foot laboratory supplied with 150 kilowatts of power and 5,000 gallons of water a day. Quarters, mess, transportation, teletype communication with the United States, and other local necessities were in process of procurement when the Japanese surrendered.

Seldom has a carefully prepared mission been terminated more quickly or more happily than ours to Manila. On August 5 we arrived in Manila; on August 6 the first atomic bomb was reported; on August 8 Russia's declaration of war was announced; on August 11 the Japanese negotiated for surrender; on August 14 they agreed to surrender; and on September 1 the surrender was formally signed. Our mission to Manila was finished. We, and thousands of others who, far more than we, had earned peace the hard way, could soon go home. It was a wonderful thought.

With the approval of the chief of staff, I sent a message to Washington cancelling all further preparations for P.B.O.S.R.D. and arranging a schedule for the orderly return to the United States of our scientists already in the Pacific. Some could go back at once, others would stay to complete some job that was important. All would be back by October 1 to help in the tremendous job of reconverting our universities and industrial laboratories to peacetime programs. Then, unexpectedly, was born the mission to Tokyo.

Even though Japanese military power was rapidly deteriorating and there had been rumors that Japan had approached Russia to act as intermediary in a peace settlement, the Japanese acceptance of unconditional surrender came with startling suddenness. Although we were elated at the quick ending of the war, our previous experience with Japanese militarism gave us every reason to proceed with that caution which would enable us to attain our objectives with a minimum of casualties on our side. None of our soldiers had set foot on the mainland of Japan, and, in spite of the rescript ending hostilities, we could not be too sure of the reception that would await our troops when we began the occupation. A host of completely new and unexpected problems suddenly confronted us, the answers to which would be of inestimable value in our occupation operations.

We wanted to know, for example, how big a threat Japan could be, even after defeat. In this war of such a highly developed technical character, how far had Japan gone either in production or in development (or even in conception) of new methods of warfare which might prove dangerous to world peace in the future? In the allied control of Japan, what scientific work should be allowed to continue as a contribution to the general welfare of mankind and what should be prohibited, at least until a peaceful regime is firmly established in the country? How had Japan organized its scientific effort in the war? What technical ideas or developments of the Japanese could we incorporate advantageously in our own future national security pogram?

Important policies and actions depended on answers to questions like these. Well-staffed investigating teams — military, economic, civic — planned to go into Japan to study these questions. In particular, every branch of the Army, the Navy, and the Air Forces began immediately after V-J Day to get technical investigating teams ready. One of these teams alone planned for a personnel of 750. Others were smaller; some of the groups may have been larger.

Actually there were very severe limitations on what could be done, and when. The main Japanese home army was intact, and there was much speculation as to what might happen when the initial contingent of a few hundred American troops landed with MacArthur to prepare the way for occupation. Would the Japanese Government control its army, its hotheads, and its fanatics? For weeks after the occupation started, the entire American occupying force could be wiped out almost overnight. Until the basic requirements for food, quarters, and safety could be provided and a working program established with the Japanese, it was obvious that investigating groups, however enthusiastic, could not be given a completely free hand to visit any and all parts of the country as they pleased.

But there was also hazard in waiting too long. War laboratories would be dismantled, their staffs scattered, and their records dispersed and possibly destroyed. So Moreland and I were asked to organize a scientific intelligence mission as quickly as possible, using scientists already in the theater. We were to get into Japan on the heels of the first occupation troops and make a rapid overall survey of such high spots as key Japanese scientists; principal laboratories under military, industrial, or educational auspices; and the Japanese organization of science for war. The results of this investigation were to be turned over to the appropriate military co-ordinating agency for guidance of all subsequent investigators and for the information of the military control office. We could have records impounded or put under guard, we might order men to appear before us, and we had power to have them arrested if they become recalcitrant.

We hoped that the Japanese scientists would co-operate so that the task would not be unnecessarily disagreeable. Fortunately this was the case. Perhaps it was helped by the fact that I had known a number of their leaders during the past 25 years, and some of them had been guests in my home.

The mission was headed by Dean Moreland and included five civilian scientists, four officers attached for temporary duty from technical military branches, three interpreters, a driver, and two stenographic clerks. We hoped to add a few efficient WACs as soon as arrangements could be made for their safe quartering in Tokyo.

Several jeeps and some office equipment completed the requirements. The mission was set up under Moreland's scientific and technical advisory staff section of general headquarters. It worked closely with the counterintelligence section, a most effective organization under Brigadier General E. R. Thorpe of which the Armed Forces of the Pacific may well be proud and of extreme importance during a very critical period.

Two weeks elapsed between V-J Day and MacArthur's landing with a small airborne party at Atsugi Airport, some 20 miles from Tokyo. This time had been requested by the Japanese to prepare their people to accept defeat — a most necessary procedure because the masses of the people, including the army, were largely unaware of Japan's desperate situation. The Japanese propaganda machine had concealed reverses and pictured strategic withdrawals as made only in order to draw United States troops into a trap for utter annihilation. To bring about a complete reversal of opinion in two weeks and to do it so completely that not a single American has yet been molested in any way, even though he be alone in a crowded Japanese district, is a phenomenal undertaking.

During this period there was great uncertainty as to what our occupation troops would encounter. If the surrendering government failed to control the masses of people and the active elements who might rebel at surrender, the situation could explode with violence. If guerrilla bands took to the mountains they could maintain violence and insecurity for a dozen years even though we might keep large numbers of troops in continuous occupation and even though such guerrilla warfare would result in the total destruction of Japan. Anarchy might ensue, leaving nothing on which to build the desired peaceable regime. The removal of the Emperor could lead to a religious war, and such wars are notable for their length and futility. The situation was extremely delicate. No wonder there has been uncertainty about the requisite size of the occupation force and the length of time it would be needed.

The pattern of Japanese reaction to the situation has become evident during the weeks of occupation. The Japanese have lived up to the surrender terms with a meticulousness thatis almost unbelievable. On our side, the situation has been handled with consummate skill, in a manner which has saved many thousands of American lives and which I firmly believe can bring about a regime in Japan which we need not fear and which will be consistent with the ideals we have professed.

For three weeks after V-J Day we were busy in Manila in preparation for our mission. Military Intelligence in Washington sent over a carefully prepared list of Japanese scientific targets. This was augmented by much additional information from the Military Intelligence services based in Manila. By teletype we were informed of the names, occupations, and addresses of all Japanese alumni of M.I.T., the California Institute of Technology, Harvard University, the University of Chicago, and the University of California.

Then four of us went to Japan to set the stage. David T. Griggs and E. G. Schneider of the Radiation Laboratory went with the first echelon of the Far Eastern Air Force, while Moreland and I went with the advanced echelon of general headquarters of Armed Forces of the Pacific. Andrew Longacre, also of the Radiation Laboratory, was left in charge of the rest of the team in Manila, with instructions to bring them to Tokyo as soon as we radioed back that conditions were possible for living and working. No one knew what conditions would be faced. We were outfitted with K-rations, sleeping bags, and shelter tents, but we decided against side arms. After four days in Yokohama we moved to Tokyo, and Longacre's party joined us the following day.

The trip from Manila to Yokohama will remain as the only distinctly unpleasant memory of the whole Pacific experience. Two uncomfortable nights on greatly overcrowded courier planes were separated by a day and a night at a casual camp on Okinawa where we were thrown off the first plane to make way for an extra batch of high priority mail and a load of gasoline. We spent this day lying naked and motionless on army cots, oozing perspiration from every pore and vainly hoping that the good Lord might set in motion even one little breath of air. That night we stretched out on top of a Shinto shrine, just to be up where a little breeze might fan us, but rain drove us in. To make things worse, water was rationed to

M.I.T. Radiation Laboratory Photo

A glass-blowing shop in the Radiation Laboratory where many new types of electron tubes were made for use in military devices during the war

two gallons a day to each person for drink, bath, and laundry. Morale was pretty low. There are some fine new layouts on Okinawa, but we did not happen to strike one of them.

In compensation for this experience we found unexpectedly comfortable quarters, first in Yokohama and then in Tokyo where, despite the terrific destruction, a few of the fine modern office buildings and hotels were intact. Frank Lloyd Wright's Imperial Hotel, or rather the half of it that survived the Tokyo bombings, provides living accommodations for the officers attached to MacArthur's staff, and his office headquarters are in as fine a modern building as can be found in the world, the Dei Ichi Insurance Building. The Imperial Hotel evoked many critical comments of extravagance and inconvenience, but all admitted the interesting character of the architecture. In any case, the Imperial Hotel provided far better living than did pup tents and it had the first hot water since Brisbane. At first, the generals' dining room was served by Japanese male waiters. There was strenuous objection to the slow service, and so the generals were moved downstairs to a corner of the big dining room, with the colonels and majors — and the dainty, attentive, stage-costumed waitresses. I thought it an excellent move. Here let me note that although we were civilians, we were in uniform with general officer privileges, and throughout we were given every courtesy and facility that could go with a general's rank and responsibility.

Our air force certainly did a job on Tokyo! For miles and miles, as far as the eye could see, the city was an ash heap. From the air it looked like a huge expanse of debris, the brown coloring of which came mostly from the rusted corrugated iron roofing lying in the ashes. The smaller masonry structures also collapsed in the fire, while many of the large modern "fireproof" structures were gutted inside, although appearing undamaged from the air.

This third largest city in the world, with its adjacent, continuously built-up cities, covers about 210 square miles and had a population of about 9,000,000 people. It had about the same area and twice the population of Greater Chicago. Now perhaps 85 square miles of the densest part of Tokyo are completely destroyed; absolutely nothing is left but ash and rubble. In the remaining parts of the city probably half the buildings are destroyed or damaged. The only intact regions are the parks, shrines, and some of the university campuses. The damage far exceeds that of the great earthquake, though the loss of life was less. No high-explosive shells were used. Some 7,000,000 of the inhabitants are reported to have dispersed to the country. In some other strategic target cities of Japan the percentage of damage was even greater, but I suppose that Tokyo is now the most extensive mass of ruin in the history of the world.

An inspection of the burned homes discloses a very significant fact. Still standing in the ashes of a considerable proportion of the homes are many machine tools, such as lathes, drill presses, and winders. These homes housed the "phantom industry" of Japan. Each family would make some repetitive part, such as a screw or a coil. From a multitude of such homes the parts were brought to manufacturing plants for assembly into war equipment. Presumably many more homes were similarly engaged in ways that do not now show and whose equipment would, unlike the lathes, have burned. The elimination of this phantom industry along with a major portion of the large manufacturing plants spelled Japan's defeat even before the atomic bomb was dropped.

Speaking of Japan's defeat, let me mention an illuminating episode, which bears on the concern (expressed by some in America) over the fact that some Japanese have not admitted defeat, although defeat is freely conceded in civilian circles.

One day, while we were questioning a Japanese army officer, he made the statement: "The Emperor told us to stop fighting, so we stopped, but we were not defeated." We asked him if he did not know that the Japanese Navy had been almost wiped out, that island after island had been lost in our steady advance toward the homeland, and that a crushing invasion of the homeland was imminent. He replied: "Yes, I know all those things, and you could have invaded Japan. But as long as the Emperor told us to fight we would have fought, and every Japanese soldier would have been killed. But we would not have been defeated."

To the Japanese, defeat is an inner spiritual thing like disgrace. But there is no disgrace in giving up the struggle when ordered to do so by the Emperor. The Japanese know full well that they failed to achieve their objectives in the war and that the war has brought them to a state desperately worse than that which they had before the war. They know that the Emperor's order was given to avert complete destruction and that the capitulation was unconditional. To the practical Anglo-Saxon mind this seems that they know they were defeated.

Granting the difficulty for an occidental to understand some workings of the oriental mind, every American in the occupation force is surprised and considerably puzzled over the apparent friendliness of the natives. Some of us attribute this to deep duplicity and sinister motives. Most of us think we can discern other predominating reasons. But first let me tell about the friendliness of the children. They are less complex and less spoiled by indoctrination than their elders. The following experience illustrates several points, all of them good.

Our first business with a Japanese scientist was to locate Hidetsugu Yagi, the "Vannevar Bush" of Japan, a former student at Harvard. This errand took us by jeep to his home in a far corner of Tokyo and off the main road. It was still a week before any allied headquarters had been established in Tokyo. We were unquestionably the first Americans to be seen along many of these streets. As we drove along, the children playing in the streets ran precipitately for cover into their homes. Sometimes a mother would dart out, snatch her offspring, drag the child into the house, and bar the door.

On the following day we made the same trip to continue our business. This time the children did not run; they stood by solemnly, big-eyed. But on the third day they began timidly to wave, and we waved back. On our return the street was full of grinning, waving youngsters, and some of the mothers looked on pleasantly.

Now, wherever Americans go, the children wave or hold up their fingers in the V-sign or try to call "Hello," and sometimes "Hello, Yank." And if an American stops, anywhere within 25 miles of Tokyo, he is likely to be surrounded by friendly appearing natives. Here is something to work on for the future. The fine performance of so many of our own Nisei in this war proves that the Japanese problem is one of education, religion, and culture rather than one of race. (*Continued on page 114*)

Chemistry Goes to the Battlefield

For an Expanded Educational Program the Institute Takes Over Its Own Chemical Engineering Building, Built Four Years Ago as Development Laboratory for the Chemical Warfare Service

By Frederick W. Holt, Jr.

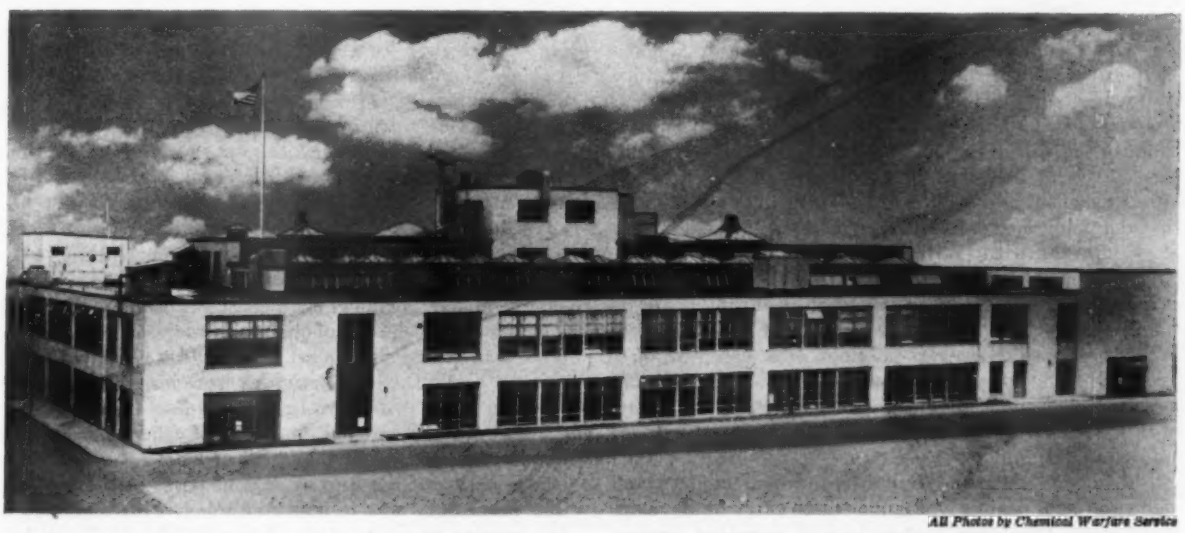
THE second largest war research unit at the Institute terminated its activities this month when Lieutenant Colonel Willard J. Slagle, '29, commanding officer of the Chemical Warfare Service Development Laboratory, returned to the Institute a building which M.I.T. had built but had never used for its own purposes. Now, after four years of service to the armed forces, the C.W.S. Development Laboratory is available to carry out peacetime instruction in chemical engineering. Like those of many other war projects, the activities of the Chemical Warfare Service were not widely publicized between November 7, 1941, and August 14, 1945, and consequently Building 12 may be a new structure to many readers of The Review.

Covering a period of little more than four years, the history of this new laboratory serves as a splendid example of the manner in which the Institute stepped forward to serve the armed forces at a time when the scientific brains of America were desperately needed.

With Germany already well launched on its program of conquest, it was clearly evident in 1940 that only by a miracle could the United States remain at peace. Plans which had been developed to provide for this nation's defense assigned an important role to the Chemical Warfare Service. Members of C.W.S., and particularly Colonel Bradley Dewey, '09, realized that the research facilities of the principal Chemical Warfare Service laboratories at Edgewood Arsenal in Maryland would be overtaxed in time of war. It was further evident that there would be danger in concentrating all research for this service at a single installation during a period of national emergency. Additional laboratory facilities were urgently required, and attempts were made to provide for the increased needs which were foreseen. According to the original plan, the new laboratory was to be a development rather than a research laboratory. It was to act as liaison between the Army and industry, and its primary function was to enable the armed forces to take fullest advantage of modern chemical research.

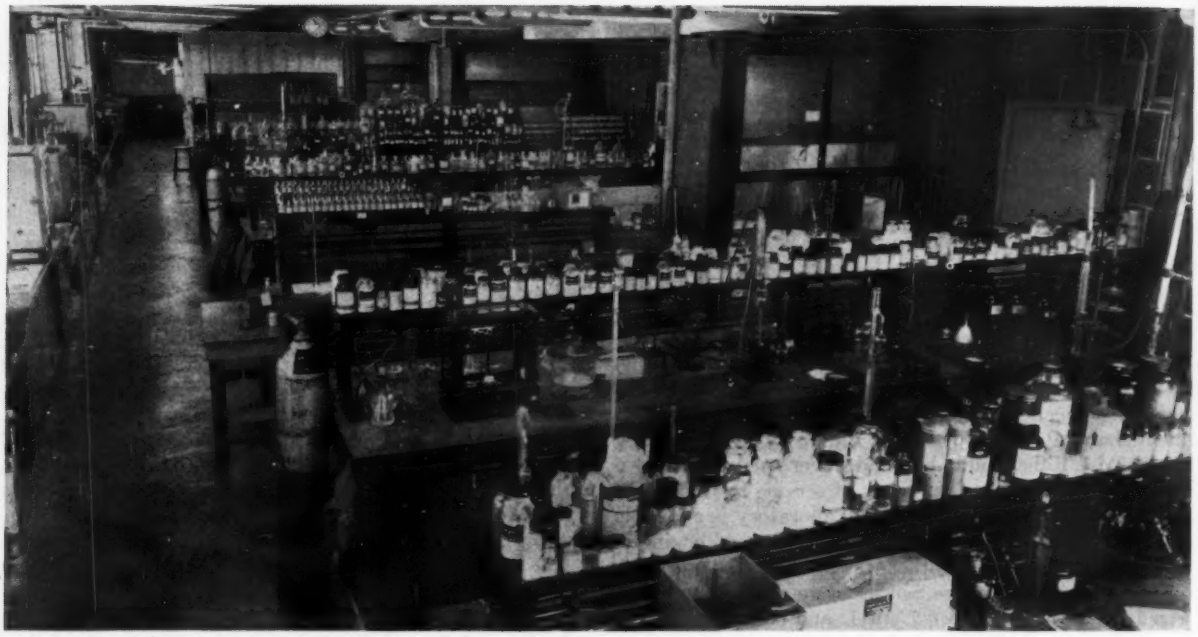
For the purpose of developing adequate laboratory facilities, informal discussions took place in the fall of 1940 between members of the National Defense Research Committee, officers of the Institute, and Colonel Dewey, representing the Chemical Warfare Service. It was pointed out that a new laboratory in Cambridge would be in the fortunate position of being able to call upon scientific personnel from the Institute, Harvard, Northeastern, and other educational institutions in the Boston area as well as technical men of the varied manufacturing plants in the vicinity. Such a laboratory would be reasonably accessible to the Edgewood Arsenal but yet sufficiently distant to provide dispersion of noncombat military effort so desirable in time of war.

Fortune smiled. The Institute already had architects' plans drawn for a new chemical engineering laboratory which would be ideally suited to the purpose. A program



All Photos by Chemical Warfare Service

General view of the three-story building built in 1941 as the Chemical Warfare Service Development Laboratory and now returned to the Institute for use as new laboratories for the Department of Chemical Engineering. The main group of Institute buildings, although not shown here, is at the extreme right.



A typical analytical laboratory in the new building. Among the projects undertaken in laboratories such as this were the development of new tests for toxic war gases and the development of new analytical tests which were adopted as standards by the chemical industry during the war.

to raise funds for the new laboratory had been interrupted, however, because of the threat of war. Upon the request of the Chemical Warfare Service, the Institute constructed its new chemical engineering building with few modifications and at its own expense. When the laboratory was finished, it was turned over to the Chemical Warfare Service for use during the war. Under the terms agreed upon, the C.W.S. could expand its research facilities under favorable conditions at a time when additional laboratories were sorely needed. At the same time, the Institute could proceed with the erection of a building which it would need for its peacetime program of instruction. Construction of the new building began in April, 1941.

On June 1, 1941, before its completion, the new laboratory was officially opened under the command of Colonel Jacquard H. Rothschild, '42. At the time, the laboratory staff consisted of five officers and one secretary and had temporary headquarters in the Department of Chemical Engineering in the basement of Building 4. By November 3, 1941 — one month before the attack at Pearl Harbor — a considerably enlarged staff was able to move into the completely new laboratory, designated as Building 12 and connected with the main buildings of the Institute. At that time it seemed that the new laboratory, three stories high and as large as a football gridiron, would be capable of meeting any future needs of the Chemical Warfare Service. However, the flood of research projects assigned to the laboratory required the addition of many new employees until the peak of 350 was reached in June of this year, and soon every square foot of available space was at a premium.

But a new laboratory building, however modern and well equipped, is not alone sufficient to carry on development work. Personnel, materials, and operating services were required, and the personnel had to be knit into a cooperative, compact organization. To handle the wide variety of projects assigned to the laboratory, the staff was organized into a number of divisions, each with its chief. The divisions were in turn composed of sections, with a leader at the head of each.

Each division in the laboratory served one of three functions: executive control, service, or research. The executive division had charge of the laboratory as a whole and performed all of the necessary administrative duties, including obtaining personnel, procuring supplies and materials, making contracts, and providing liaison. The service divisions were responsible for providing all services required by the laboratory. Under the direction of these divisions were included an editorial group charged with the publication of laboratory reports, a library, stock rooms and tool cribs, a photographic laboratory, a printing shop, a shop for glass blowing, an analytical section, and an engineering section in which were included the machine and carpenter shops and drafting rooms. Occasionally the engineering and analytic sections carried on research problems for which they were equipped, but their main function was to provide service to the other divisions of the laboratory. The research divisions were responsible for carrying out the research activities of the laboratory and were divided into groups according to the type of work on which research was required. There was, for example, a chemical engineering division, whose work included establishment of chemical processes, operation of pilot plants, and similar activities, and a chemical development section, whose activities were largely directed to the development of new organic chemicals.

Laboratory personnel consisted of Chemical Warfare Service officers and civilians, all of whom were chemists or engineers recruited from various parts of the country. The laboratory was in constant touch with members of the regular Institute staff. Professor Harold C. Weber, '18, and Scott W. Walker, '40, and Roy P. Whitney, '35, associate professors, all of the Department of Chemical

Typical of several organic chemistry laboratories in the new Chemical Engineering Building is this room where work on jellied-gasoline flame throwers was undertaken by the Chemical Warfare Service during the war.

Engineering, were assigned on a full-time basis to assist the laboratory with its many projects.

Women too rendered assistance. Fortunately, chemistry is one field of science which has greatly appealed to women, and the previous chemical training of a number of women qualified them for special technical tasks. Others were prepared to work on the drafting boards or as laboratory assistants or operators of special instruments. Their adaptability and enthusiasm for their assignments played a decisive part in the successful operation of the laboratory.

Research projects assigned to the laboratory covered a wide range of topics and required the use of all branches of knowledge from ablution to zymurgy, including anthropology and a great deal of electronics. Although it is not possible to provide comprehensive treatment of even the major research tasks undertaken by the laboratory, an attempt may be made to outline a few representative projects.

Upon completion of the new quarters, all research on gas masks was transferred to the laboratory, and the development of new designs was undertaken. At the beginning of the war, the standard service mask was bulky and heavy, whereas a lightweight, hoseless mask was required for combat service. As part of the gas-mask project, an anthropological survey was made of the faces of men in the Army in order to produce a minimum number of designs which would fit all physiognomies. As a result of this survey it became possible to standardize on three sizes of masks. One of the illustrations shows the model of a man's head, synthesized from measurements in our survey and adopted as one of the three standard sizes. The anthropological survey is believed to be the most extensive of its kind thus far conducted, and the results of this study are applicable in the design of such products as hats, glasses, goggles, and other items that must fit the face or head. The work on gas masks also resulted in the use of more effective chemical fillings, better filters, and a lighter weight canister.

The laboratory's chemical engineering activities were devoted primarily to a study and development of new and improved chemical processes. The results of this program were applied with considerable success in many plants producing chemical products. Included in this program were the construction and operation of several pilot plants, one of which was carried to a semiworks scale, producing each day several tons of a much needed war chemical. Flame-thrower fuels and guns

Among the projects undertaken in the mycology laboratory shown above was the program for developing methods of combating fungi and bacteria, which proved troublesome in the early phases of fighting in the Pacific. The work done at the laboratory was effective in saving from premature spoilage much equipment intended for use in the tropics.

were investigated by several groups, and an indoor range was set up for test purposes at Lawrence, Mass. Extensive studies were made on jellied gasoline, which appeared to produce the best flame under highly diversified conditions such as might be encountered in actual combat. New guns, control valves, and pressure tanks were devised both for mechanized units and for portable use.

The war offered our first encounter with conditions experienced in the tropics. In the early phases of fighting in the Pacific, many items of military need deteriorated rapidly because of humidity, fungus, and growth of bacteria. This laboratory inherited the task of devising means for combating mildew and for producing fungi-proof materials. The mycologists at this laboratory were able to develop formulas providing complete protection against organisms producing rot or mildew under tropical conditions. The beneficial results of this research were extensively used by the entire Army.

Originated for military purposes but having useful application in civilian industry were the detectors for toxic gases which were either improved or invented at the laboratory. Detector materials of greater sensitivity than had previously been known were discovered. A new kit, weighing but two and a half pounds, was constructed, with which the presence of any of the war gases could be detected. The laboratory carried out the entire production of one of the detectors for the allied armies. Gas-sensitive papers, crayons, paints, and similar materials were also developed as part of this program.

The scarcity of natural rubber presented a great problem in the manufacture of many items used by the Chemical Warfare Service. A rubber section, completely equipped with mills, calender, and hydraulic press, was organized to carry out development on the compounding of synthetics for use in molded articles or for coating and impregnating. This work resulted in new rubber compounds having much better cold flexibility, greater strength, and reduced curing time than had previously been known.

A group studying fabrics developed a fireproof cloth that could be laundered without losing its noninflammability. Coated and impregnated textiles were improved to a point where the toxic gas resistance was five times as great as it was for pre-war materials. Miticide-resistant clothing was made and proved to be of great value in the South Pacific area.

One of the long-range projects of the laboratory was the examination of captured enemy chemical warfare equipment and its comparison with equivalent products of the allies. The work in this field was not only of great value to the Chemical Warfare Service but was also of considerable aid to our country's Military Intelligence.

Perhaps the most interesting of the laboratory's projects is the last to be discussed. Although every possible effort was made to make the results of chemical research available for military purposes, it was felt that armies in the field required a mobile but completely equipped chemical laboratory. Such a unit, consisting of several motor-drawn trailers, was designed by the laboratory to bring chemistry to the battlefield. Although the mobile unit is very compact, it is supplied with all the essential features of a modern chemistry laboratory. Not only has it been used in making special analyses of war gases but it has also served as a general laboratory for any chemical problem that might arise in the field.

When required, developments were supervised in factories, and in several cases assistance was given in setting up and operating production lines. Frequently it was found that new methods of evaluation were desirable, and improved analytical procedures were devised, many of which became standard in industry. New testing instruments were designed and produced to aid in analysis and inspection of Chemical Warfare products, and facilities were built for testing military equipment under desert, tropical, and arctic conditions. It is impossible to give a detailed description of the many research projects carried out at the laboratory, but the examples mentioned here should serve to give an indication of the diversity of problems which were assigned to it and which were successfully carried out.

The wholehearted co-operation of the Institute and its staff illustrates the very close interrelation between the normal peacetime activities of institutions of higher learning and the nation's wartime needs and thereby gives additional evidence for encouraging education in science and engineering. Wherever scientists meet on a basis of mutual understanding, a happy productive relationship is established which is capable of satisfactorily overcoming many difficult problems. Certainly this has been the experience of those who have worked in the Chemical Warfare Service Development Laboratory during the last four years.

Model of head of "Mr. America, No. 3." The model is synthesized from measurements of thousands of men in the Army.

Where Is the Long Hair?

In Exploding the Popular Misconception of Research Men, the War Has Also Shown the Need for Widespread Training in Science

By Philip M. Morse

DURING the next few years many lessons will be drawn from our war experience concerning the interrelations between science, warfare, and the social-economic activities of the country. One lesson, which has already been learned by the armed services and by industry and which perhaps is coming to be realized by the general public, is that pure research scientists are not all the long-haired, impractical dreamers which the general public has taken them to be.

In popular fancy, the academic scientist has been the absent-minded specialist, immersed in recondite trivialities, to be patronizingly patted on the head occasionally but never to be allowed to interfere in "practical" affairs. However, during the war a great number of academic scientists gave up pure research and, through the Office of Scientific Research and Development, headed by Vannevar Bush, '16, made effective contributions to practical affairs. The record of their contributions belies the popular connotations of the word "professor."

It is not particularly surprising that the men of science were pre-eminent in technical research and development of military applications. Pure science has recently compiled a large body of comparatively unapplied knowledge and has developed a large number of highly complex instrumentalities in the course of its exploration of atoms, electrons, and nuclei. This knowledge and these instrumentalities have immense potentials for useful application in industry and commerce, which would have taken 25 years to become realized in normal times.

Normally, the engineers would have moved into this field gradually, learning the instrumentalities and techniques from the pure scientists and building from them practical applications for the everyday world. The businessmen would have eventually seen to it that the equipment developed by the engineers got into everyday life, and the military men would have ultimately learned to apply the equipment to tactics and strategy. Such is the normal peacetime sequence of events. Suddenly, under stress of war, these applications had to be made in one or two years instead of 25. Workers in pure science had the knowledge which had to be applied; but who was to do the engineering, who was to oversee the production and the military use of the new equipment, who was to take over so rapidly from the long-haired scientists?

The answer, of course, was not univalent. A great number of engineers were able to learn the salient facts of nuclear theory, electronics, and electromagnetic theory rapidly enough to make important contributions in the application of these fields. A number of military officers were able to learn enough modern science to be able to use these new instrumentalities effectively in operations. But a great deal of the engineering, administration, and tactical planning was necessarily done by the academic scientist, and it was done well.

From one point of view, it is to be regretted that it has been necessary to turn the channels of science into methods of destruction, and no one regrets the need for such action more than the scientists themselves. At the same time, in a war in which the subjugation of nations and even continents is at stake, the scientist, like any other citizen, must conform to the patriotic duties which his nation and society at large impose upon him. The scientist is perhaps somewhat more fortunate than some of his fellow workers in other fields in that the results of his war work lead to useful peacetime applications.

It is possible to cite many examples in which the professional scientist performed valuable services in engineering, production, or in military planning. A list of names and services would monopolize this issue of The Review. A few examples, selected from the author's acquaintance, are given in this article as being typical; however the few enumerations given here preclude any attempt at completeness.

In a number of cases, the scientist did the engineering work on the development of new weapons because it was quicker for him to apply the principles of science than it was for the engineers to learn the principles of a new branch of science. This is not to say that the practices required by war exigencies are necessarily the best ones to follow in peace; it does indicate that our scientists have latent and additional talents which have not previously had opportunity for expression.

Professor John C. Slater, Head of the Institute's Department of Physics and author of many papers on quantum theory and several books on theoretical physics, spent two years at the Bell Telephone Laboratories supervising the development of engineering principles of design of power sources for microwave radar sets. His work is basic for future electronic engineers. During the war, Professor Luis W. Alvarez, physicist at the University of California and co-author in 1940 of a paper on "A Quantitative Determination of the Neutron Moment in Absolute Nuclear Magnetrons," was responsible for the development and engineering design of one of the most accurate radar methods of bombing through overcast, which was used with great success by our B-29's against Japanese cities. He is also responsible for the design of the most practicable scheme known at present for landing planes through fog — the plan which has saved many a B-29 and crew.

Not infrequently the scientist had to go beyond the engineering phase and help in the planning of production because it turned out to be easier for him to learn the production problems than for the production engineer to learn the new theory in a hurry. Examples of this sort of utilization of pure scientists have been particularly prevalent in the development of the atomic bomb. Here, workers in theoretical physics had to turn metallurgists;

cyclotron experts had to design calutrons (the modified cyclotron) for mass production of U-235; and chemists, customarily engaged in theory, were an active help in solving the practical problems of immense complexity which arose in isotope separation.

In this huge project, academic scientists have also proved their ability as administrators of large organizations. Professor J. Robert Oppenheimer of the University of California, author of "On the Applicability of Quantum Theory to Mesatron Collisions" and many other papers on nuclear theory, supervised the immensely important development work on the atomic bomb done at Los Alamos, N. M. In many other fields academic scientists took an active and effective part in the planning and administering of large-scale engineering and production of war equipment.

But the object lessons of the past five years point still further. Many of the most important new instrumentalities of war involve principles so new that most military men were ill-equipped to understand them or to plan for their effective use in operation. Although many regular officers dug into the unfamiliar fields and learned enough of the scientific background to be able to devise adequate tactics for the new weapons, here again in many cases it was easier for the academic scientist to learn tactical and strategic theory and then to help in devising military doctrine and in simplifying logistics.

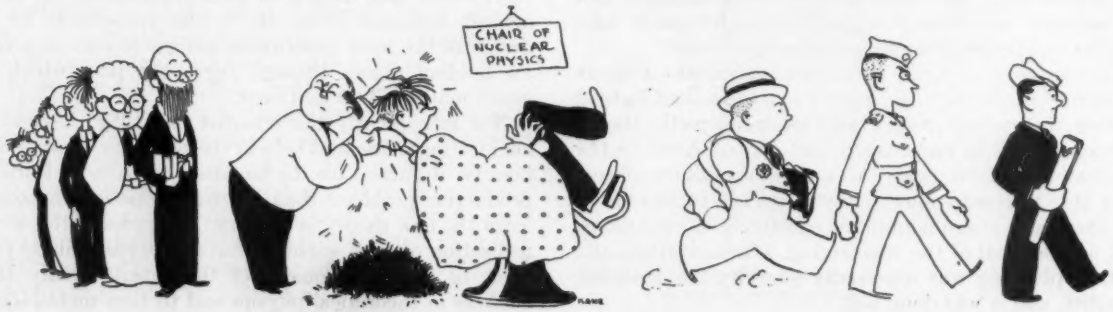
The contact between the military service commands, the laboratories, and industry has been made more effective by the assistance of pure scientists. Two examples will suffice to illustrate this statement. Professor Julius A. Stratton of the Institute's Department of Physics, author of "Elliptic and Spheroidal Wave Functions" and many other publications, has rendered immensely valuable service as an expert consultant to the Secretary of War. He helped the air forces operational commands, the service forces, and the executives of the electronics industry to reach common agreement on needs, uses, and priorities for radar equipment.

William P. Allis, Associate Professor in the Department of Physics at M.I.T. and co-author of "A Theory of the Townsend Method of Measuring Electron Diffusion and Mobility" and other papers, first as major and then as lieutenant colonel in the service forces, has been a most successful liaison officer between the Army Service Forces and the National Defense Research Committee laboratories. It is interesting to note that in such activities as these the essence of success lies in obtaining the co-operation of large groups of personnel — a field in which the scientist was supposed to be deficient.

The scientific method has proven to be the key to these varied achievements. It is therefore not surprising that research men, long accustomed to the scientific attitude, have been able to make important contributions to the theory and practice of military tactics and strategy. The principles of the scientific method are applicable in all branches of endeavor. As with the other examples given, the point is not that the pure scientist was necessarily better than anyone else in making these applications but that he could and did become practical, that he could learn other fields of activity to which his specialized scientific knowledge and way of thinking was readily applied. In the difficult field of devising the most efficient co-ordination between the new military equipment, the usual weapons of war, and the soldier and sailor who must operate them, it often turned out to be easier for the scientist to learn the details of military doctrine and to become a tactician than it was for officers to learn the scientific background of the new equipment.

The field of applying scientific principles to military operations has been called operations research. Very little can yet be said concerning this important field of application of science because of security restrictions, but it can be pointed out that all the headquarters staffs and many of the field staffs of the land, air, and naval forces of the United States and England have had operations research groups acting as advisors. Professor P. M. S. Blackett, formerly of Cambridge University and the University of London, a well-known research scientist in nuclear physics, became the chief scientific advisor of the first Sea Lord of the British Admiralty and made numerous important contributions to the successful operation of the British fleet. The studies of his group, for instance, on the size and formation of merchant vessel convoys resulted in recommendations which substantially reduced the number of ships lost to U-boat attack in the North Atlantic.

Many scientific men worked with the operating forces at outlying bases, developing practical applications of general scientific principles as the needs arose. Robert F. Rinehart, assistant professor of mathematics at the Case School of Applied Science, as scientific advisor to the staff of the commander of the United States submarine forces in the Pacific made important contributions toward sweeping the Pacific clear of Japanese shipping and toward keeping our submarines from being sunk in the process. John R. Pellam, '40, who interrupted his graduate work in theoretical physics at the Institute to volunteer for operations research, was able to combine his technical knowledge of special equipment and his knowledge of the tactical situation at the Gilbraltar and Morocco sea frontier, where he was stationed, to suggest special tactics which kept eager U-boats out of the Mediterranean during the crucial (*Concluded on page 130*)



THE INSTITUTE GAZETTE

PREPARED IN COLLABORATION WITH THE TECHNOLOGY NEWS SERVICE

President's Report

IN concluding the comprehensive condensation of President Compton's report to the Corporation (of which the activities of the Radiation Laboratory were summarized in the November issue), The Review now turns to that portion of the report dealing with the impressive program of war activities which were entirely under the Institute's direction.

The Draper Computing Gun Sight. Next to radar, the M.I.T. development most extensively used in the war was probably the Draper gun sight, which introduces the proper lead angle in firing at moving targets, be they tanks or airplanes or ducks. Some 80,000 are reported to be installed on naval vessels for direction of the vessels' lighter, fast-firing antiaircraft guns, and they have turned in fine performance records against attacking Japanese aircraft, especially the suicide planes. The existence of this weapon and some information about it have already been released by the Navy.

This is one of a series of devices employing gyroscopic principles which were invented and built by Professor C. Stark Draper and his able associates in the Instruments Laboratory of the Department of Aeronautical Engineering. The work began several years before the war, resulting first in a turn-and-bank indicator for aircraft piloting. In 1940, the Sperry Gyroscope Company gave the Institute a generous backing to finance the development of a lead-computing sight based on the turn-and-bank indicator previously developed for Sperry.

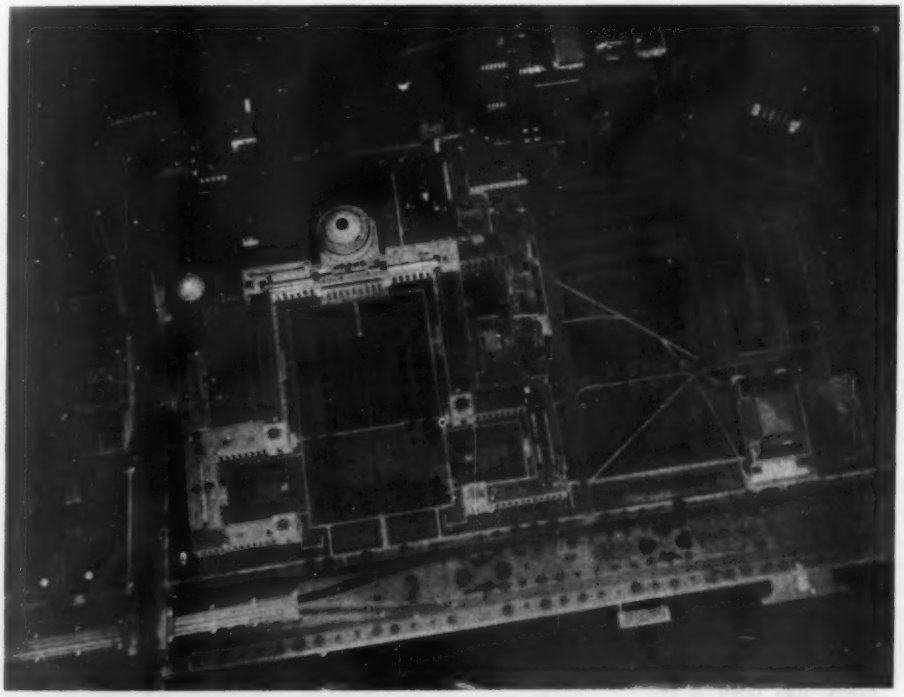
The Instruments Laboratory has been continuously occupied with advanced fire-control research for both services; the program undertaken during the war, which will continue in part until certain specific tasks are completed, provides the basis for a fundamental attack on peacetime problems of control and instrumentation. The prime objective of this laboratory is the education of students on an advanced level in the philosophy and techniques of instrumentation, and the specific research projects undertaken for government and industry by the group have led to advances in the art which will be reflected in the educational program.

The Servomechanisms Laboratory. For some years, the Institute has pioneered in the theory of servomechanisms and, as far as I know, has been the only educational institution to maintain a laboratory and educational program in this little-known engineering field, a field evidently destined to increase rapidly in importance as automatic controls of machinery multiply. This laboratory, under the leadership of Gordon S. Brown, '31, Associate Professor in the Department of Electrical Engineering, has been an important national asset during the war, both in developing equipment and in raising the level of the art of servomechanisms among the chief manufacturing concerns involved in production of devices for transmitting rotational motion with power amplification.

With a staff of 140, the laboratory developed mechanisms which, with great accuracy and stability, followed the direction given by fire-control computing devices, thus providing an essential link between the source of the information and the gun position. Among the important types of guns thus equipped with servos developed in this laboratory are the 40-millimeter antiaircraft gun of the Army and a similar unit for the Navy.

The laboratory also, by direct research and consultation, aided importantly in the more refined development of automatic controls and in analytical application to the design of dynamic systems. Here again the laboratory originated, and in fact continues, as an educational program. Prior to the war, Professor Brown and his group, together with Professor Draper, were engaged in teaching fire control to naval officers and in developing laboratory facilities for this purpose, and along with this educational program they developed an organization and method of attack which enabled them successfully to meet the very complex problems of control arising during the war.

(*Continued on page 126*)



This night photograph of the Institute was made by means of 1,500-pound electric flash illuminating equipment for airplanes, developed during the war by Harold E. Edgerton, '27, Associate Professor of Electrical Measurements, and his associates as an outgrowth of their earlier work in stroboscopic and intermittent illuminants. The single flash required for making this photograph at an altitude of 3,500 feet was produced by discharging a capacitor through an illuminating discharge tube. During the war, air-borne flash units, such as that used in making this picture, were employed to photograph night operations in enemy territory.

Institute Finances

CONSIDERABLY expanded beyond normal by war research and training programs, the Institute's finances for the 1945 fiscal year are disclosed in the annual report of Horace S. Ford, Treasurer of the Institute.

Excluding investment turnover of approximately $25,000,000, the financial operations for the past year reached a new high with a total in excess of $45,000,000, of which more than $5,000,000 was for the usual Institute operations. Contract operations of the Division of Industrial Coöperation, which had 148 contracts in force on June 30, accounted for the remainder — just short of $40,000,000. Of this, $12,500,000 went for salaries and wages, $24,000,000 for materials and services, $2,000,000 for travel, communications, shipping charges, new construction, and related operations, and the balance of $1,312,000 was allowed the Institute as overhead in reimbursement for administration and plant expenses and for use of Institute property. The major portion of D.I.C. expenditures was for the Radiation Laboratory, which was approaching a $5,000,000-a-month gait when V-J Day arrived.

	1942	1943	1944	1945
Annual increase in volume over previous year, per cent		91	70	57
Per cent overhead allowed for wages and salaries	41.3	13.6	12.2	10.5
Per cent total revenue	11.0	5.7	4.5	3.3

The four-year summary of contract operations, included for the first time in the Treasurer's report, shows progressive increases in volume over previous years since 1942, accompanied by progressive decreases in overhead and total revenue allowed the Institute, as tabulated above.

The total of overhead allowances for the four years is somewhat more than $4,000,000, of which more than $3,000,000 was reimbursement to the Institute for direct out-of-pocket operating expenses. Somewhat less than $1,000,000 was paid for the use of space and for the depreciation of equipment. After the wear and tear and almost complete deferred maintenance during the past four years, there remains for rehabilitation and renovation less than $1,000,000. All of this and more will be required to place the Institute in a position to meet its already evident postwar needs.

There has been a persistent build-up of our scholarship and other funds in the past four years. The amount of cash belonging to the Endowment and Other Funds, ordinarily invested but since 1942 advanced to finance the contract and other wartime operations of the Institute (exclusive of the Radiation Laboratory), was $3,400,000, slightly above the figure for last year. During the past year, Endowment and Other Funds have increased $2,900,000. Of this, $1,250,000 is from capital gifts, including funds advanced for the building of a new library, and nearly $1,000,000 has resulted from profits on the sale of securities in the last two weeks of the fiscal year. The balance was in income added to the funds and not expended and from transfers of certain current balances for investment purposes.

General Kenney Visits Technology

CLIMAXING a two-day welcome from his home city of Boston, General George C. Kenney, '11, was greeted at the Institute on October 19 by President Compton. Accompanied by his longtime friend, Orville B. Denison, Secretary of the Class of 1911, and his brother-in-law, Leslie G. Glazier, '11, General Kenney made a whirlwind tour of a number of the major war research laboratories at the Institute. Here he met face to face for the first time some of the scientists and engineers who pioneered in the development of the instruments that proved so useful to him and his valiant forces in carrying out the aerial campaign leading to the defeat of Japan.

Alert to the power of technical superiority, General Kenney was liberal in his praise of the Institute's accomplishments. At the same time, he provided constructive and practical suggestions for the future development of the instruments for both peacetime and military uses.

A highlight of the occasion was the reunion of General Kenney and Lieutenant Colonel Jay Zeamer, Jr., '40, holder of the Congressional Medal of Honor, who served

M.I.T. Photo

Boston's home-coming celebration for General George C. Kenney, '11, included a visit to some of the Technology laboratories where much of the newer developments in military equipment were originated and perfected. Shown in the usual left-to-right order in Dr. Compton's office before the tour of laboratories are Orville B. Denison, Secretary of the Class of 1911, General Kenney, President Compton, and Leslie G. Glazier, '11, brother-in-law of General Kenney. General Kenney is the first of the prominent military Alumni to be welcomed back to the Institute.

under General Kenney in the Pacific until he returned to this country for hospitalization as a result of combat wounds. Since his release from active duty, Colonel Zeamer has been a student at the Institute and was recently awarded the master's degree in aeronautical engineering.

Of the many high ranking officers among Technology Alumni who have distinguished themselves in World War II, General Kenney is the first to receive an official homecoming welcome by the Institute.

After leaving Technology, General Kenney became associated with his brother-in-law for a number of years in the engineering and contracting business. He began his military career by enlisting as a flying cadet in June, 1917, and held a captaincy at the end of World War I. Early in 1940 when this country first recognized the threat of war, he was commissioned a lieutenant colonel and then rose rapidly to brigadier general in January, 1941, to major general in February, 1942, to lieutenant general in October, 1942, and to general in March, 1945.

Visiting Committee Report

THE Committee on Architecture and Planning* met on March 9 and reviewed the curriculum of the School, visited the Rotch Library and examined its requirements, and made recommendations for improving the William Emerson Room, a lounge on the fourth floor of Building 7, set aside for the use of students of the School of Architecture and City Planning.

The principal concern of the Committee was with certain problems relative to the curriculum. It is the purpose of the School to have a strong framework of study clearly connected with the scientific and technological forces of the Institute. However, there must also be a strong accent on the social and humanities side of the Institute program. Problems arise in attempting to fit the first and second year curriculum of the School into the standard course of instruction at the Institute. To integrate its instruction with the courses generally required in the first two years has been somewhat difficult for the Course in Architecture and particularly difficult for the Course in Planning. In view of the existing standing of this School at M.I.T. and its tremendous future possibilities, it is the considered opinion of the Committee that some minor adjustment should be made whereby courses of study which seem to be essential to Planning can be provided, particularly in the second year curriculum. The Committee did not go into detail in this matter since the problem is already well defined. The members did express their belief that conformity with the general curriculum which has been worked out for all Courses is of less importance than making such adjustments as are required to give the best possible training in Architecture and Planning.

It is the intention to expand the graduate work within the School. There are possibilities of commercial and also fundamental research, both of which are made appropriate by the connection between this School and the Institute as a whole. There is no question but that technology in the broad sense is becoming a dominant factor in the fields which the School occupies, and we are well on the way to realize the possibilities.

The Committee visited the Rotch Library and considered its needs. As the Central Library staff is increased, it may prove advisable to ask them to do a greater amount of the work of the branch library than they do at present, such as cataloguing the books. The Rotch Library needs greatly increased funds for new accessions, which, in the judgment of the Committee, should be concentrated on current literature in architecture and city planning rather than to any great extent on historical material. As an example, the School is working rapidly toward such modern problems as airport location and design, for which it is extremely important that pertinent information should be made available.

The Committee hopes that the William Emerson Room can be refurbished before being returned to the exclusive use of the students of the School. The room has great possibilities which are a long way from being realized. Put into proper shape, it should and can serve as a

* Members of the Committee for 1944–1945 were Ralph E. Flanders, chairman, Harry J. Carlson, '92, Ralph T. Walker, '11, Louis H. Skidmore, '23, Gordon Bunshaft, '33, captain, United States Army, George Howe, and Gordon S. Rentschler.

M. I. T. Photo

The Institute's new differential analyzer, whose operation on war research projects during the past three years was publicly announced last month, is inspected by (left to right): Professor Henry B. Phillips, Head of the Department of Mathematics; Vannevar Bush, '16, inventor of the original differential analyzer, who, while at M.I.T., initiated the work that led to the new machine; Professor Harold L. Hazen, '24, Head of the Department of Electrical Engineering; and Professor Samuel H. Caldwell, '25, director of the Center of Analysis in the Department of Electrical Engineering.

Great Court of the Institute showing some of the military equipment displayed during the Victory in Science exhibit held on November 10, 11, and 12. Many people are lined up along the Charles River bank watching the Coast Guard demonstration of a rescue from a downed plane by helicopter.

common center for the contact of students with each other and be of definite service in generating and maintaining in the School that spirit which is necessary to make it a successful organization.

The spirit of the School is excellent, organization is well under way, and the Committee has no fears as to the future of the School in the postwar years.

Victory in Science

MORE than 75,000 persons attended a Victory in Science exhibit held at Technology on November 10, 11, and 12, when the Institute, in co-operation with the Massachusetts War Finance Committee, displayed new weapons of war in the Great Court and also in the field between the Institute's main buildings and Walker Memorial. In addition to the extensive exhibit of war equipment, certain of the Institute's laboratories were also available for inspection. Admission to the exhibit was through purchase of war bonds.

Institute exhibits on display included the automotive laboratory where Rolls Royce and Allison engines, an 1800-horsepower radial aircraft engine, and demonstration cut-away models were in operation; the 2,500,000-volt Van de Graaf belt-driven generator used in research on atomic nuclei; and the huge Wright Brothers Wind Tunnel used for studies on aerodynamics.

An exhibition of 160 Navy photographs on the general theme "Power in the Pacific" were on display in the first floor halls of the Institute, and motion pictures of the atomic bomb explosions were also shown.

In tents and open structures adjoining the Institute buildings recently developed military equipment was displayed, while the Charles River was the scene of rescue demonstrations staged by the United States Coast Guard.

Radar formed an important part of the exhibit. The SCR-584 mobile set, used effectively against buzz bombs in England, the Ground Control Approach radar system for guiding plane landings to airports, radar systems for bombing ships and night fighters, and radar-directed searchlights were in operation.

The Navy's exhibits included a Mark II basic training turret, a gunairstructor, a star recognition trainer, accurate scale models of Navy ships, a dual projector trainer, and the Avenger plane with folding wings. A flotilla of surface vessels, including PT-boats and landing craft, cruised on the Charles River.

The Army's exhibit included a 120-millimeter substratosphere antiaircraft gun, a recoilless gun, a 40-millimeter antiaircraft gun and Mark 51 remote indicator, a Sherman tank with flame-throwing equipment operating for more than 100 yards, and the Army Quartermaster show — broken down into four categories: clothing, food, fuels and lubricants, and mobile equipment — displaying facilities and equipment provided to troops.

Several interesting demonstrations were operated at various times throughout the day. Among these were the Edgerton Flash Unit, making possible the night photography of enemy country from planes; demonstrations of parabolic focus for searchlights and radio systems; and a demonstration of a communication system employing a light beam as the connecting "circuit."

German V-1 bombs, prefabricated harbors made in sections and floated across the English Channel for use in the Normandy invasion, and a unique bombing trainer device using the principle of controlling the bomb on the course it takes from the plane to target were also exhibited.

The Victory in Science exhibit provided the first opportunity for many persons to see the military devices which had been developed (many of them at the Institute) for use in World War II. (*Continued on page 122*)

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MISSION TO TOKYO

(*Continued from page 102*)

I should not give a false impression by overdrawing this picture. Of course, the Japanese, for the most part, cannot be glad we are in their country as conquerors. But the worst elements seem to be respectful at least. It is surprising and fortunate that so many of them, in city and country, and especially the younger Japanese — those less than 30 years of age — seem responsive and even cheerful. I think the reasons include the following:

(a) The Japanese people are very disciplined and very polite.

(b) The Emperor told them to co-operate in carrying out the surrender terms.

(c) They have lived so long almost as serfs under a military feudal system that the change from one overlord to another or to a new set of rules is accepted as a matter of course.

(d) Mixed with an inferiority complex is a deep-seated admiration for many features of the western civilization.

(e) Very many of the best citizens have sincerely disapproved of the imperial policies of the last few decades and have resented the assumption of dictatorial power by the military clique but have been powerless to prevent it. These include many industrialists, scholars, and other educated people. They see in the present events the breaking of the iron grip of the military caste and a chance, if they co-operate well with us, of creating a new era for Japan, based on civil liberty and peaceable achievement.

In any case, those who are sincerely in this latter category should be encouraged, for they are the nucleus on whom we must build if we are ever to get out of Japan without failure to achieve that for which we fought so long and expensively. Interpreting what I have seen and heard since our occupation, I judge that this is exactly MacArthur's policy and that he is going ahead with it just as fast as military security and public reaction permit. Of course, there remain some plotting Japanese who must be downed with an iron hand whenever detected. Our surest long-term antidote to them lies in backing their countrymen who sincerely wish to establish the policies which we can approve as leading to international harmony and humane internal conditions.

Our own Army and Navy occasionally had their difficulties in working together, but their differences were very minor indeed, whereas their co-operation was generally excellent. But in Japan the relation between army and navy was almost that of enemies. We asked a dozen different well-informed people, "How did the army and navy co-operate?" The answer was unanimous: They didn't. A top scientist-engineer said: "A general and an admiral would not shake hands even if that would win the war." Another replied by expressively wiggling his thumbs in opposite directions. Technically the navy was more advanced. Politically the army was in the driver's seat.

Similarly, Japan's army or navy utilized its civilian scientists only to a trivial extent and then under impossible restrictions of secrecy and suspicion. Said one scientist, "They treated us almost as if we were foreigners."

Said another: "We wanted to work for our country, but what could we do? They would ask us to develop a

(*Continued on page 116*)

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MISSION TO TOKYO

(*Continued from page 114*)

very sensitive radio amplifier, for example, but they would never tell us what it was to be used for or what it had to work with. All the parts were developed by different scientists in complete isolation and ignorance. Of course, when the parts were put together they would not work together as a system."

The reason for Japan's striking failure to utilize her top-flight scientists effectively in the war effort could be pieced together with considerable certainty from the corroborating testimony of many witnesses. First in importance is undoubtedly the dictatorial attitude and self-confidence of the Japanese military leaders, whose attitude was reflected throughout their organization. In many cases the military technologists were not so highly trained as the civilian scientists. This state of affairs resulted in a tendency for the military personnel to maintain their positions and protect their reputations by avoiding frank discussion with the better trained civilian scientists of the universities and industrial companies.

Contributing also to the situation was the fact that, for the most part, the top Japanese scientists were educated in America or Europe, or had at least made frequent visits to these continents. They were therefore suspected of foreign connections and sympathies. Furthermore, through their foreign visits, they had a yardstick against which to measure Japan's policies and powers, and most of them realized only too well that the Japanese imperial policy was headed for catastrophe. As a group, therefore, the Japanese scholars were unsympathetic with their nation's war policies and hence were not trusted.

To some extent, this last comment is also true of the navy, whose officers had also seen the world and were not at all confident of the possibility of Japan's military success. The predominating army group on the other hand came from the peasant class and did not have much basis for international comparison. The average army man thought the textile mill, steel mill, or arsenal in his home town was the largest in the world, and his military ambition was therefore not tempered with wholesome caution.

How different are these relationships from the working partnership established between our Army and Navy, our industrial companies, and our civilian scientists under the O.S.R.D. In comparing the co-operation and the over-all effectiveness of the technological war effort of the United States and Great Britain with that of Germany and Japan, we are forcefully reminded that the democratic nations showed far greater initiative, co-operation, and efficiency than did our totalitarian, dictator-driven opponents. In their republican form of government, our democratic processes have stood the acid test of war; may they likewise stand up to the emergencies of reconversion to peace!

It would be improper to discuss here any technical war developments, but I think the proprieties would permit the following comments on Japan's progress in the two most important scientific developments of this war, the atomic bomb and radar.

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(*Continued on page 118*)

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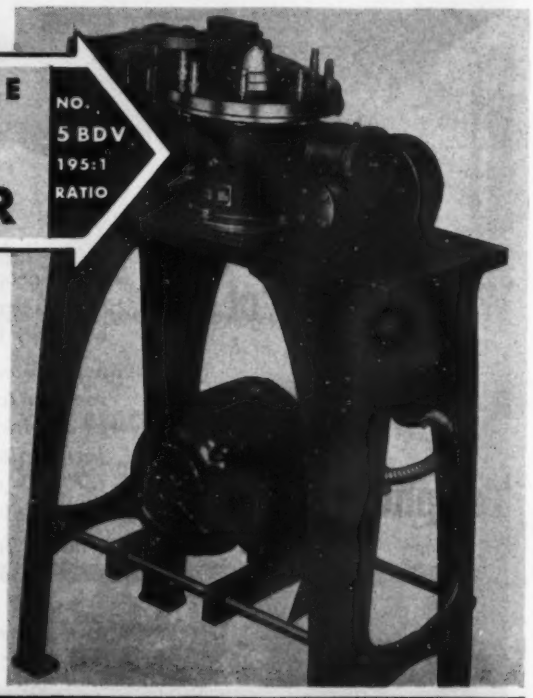
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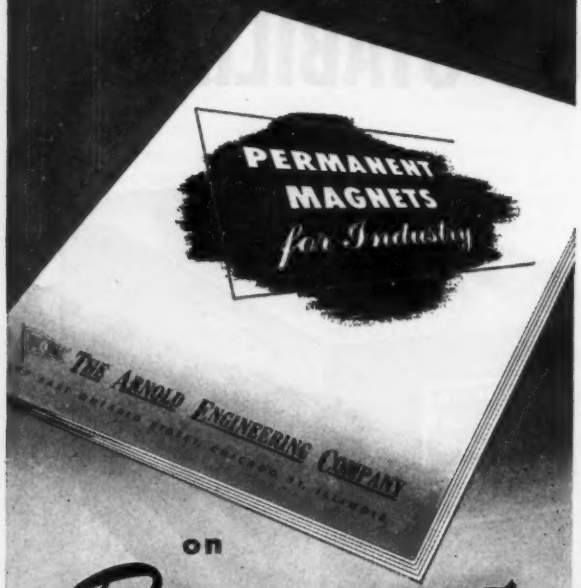

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MISSION TO TOKYO

(*Continued from page 116*)

Japanese physicists were aware of the theoretical possibility of producing atomic power. Some of them thought of the possibility of an atomic bomb, but their theoretical calculations mistakenly led them to conclude that the release of atomic energy could not be rapid enough to produce an explosion. Their mistake is not surprising, since the calculations involve concepts which make even Einstein's relativity theory look simple by comparison. But because of this error, the Japanese effort was directed at producing an atomic energy substitute for coal for power plant purposes. A laboratory apparatus was constructed on a small experimental scale, employing a principle for concentrating the desired Uranium 235 which would immediately occur to any competent physicist or physical chemist. But before any tests were made, the apparatus and its laboratory housing were completely destroyed in one of the bombing raids, and these facilities were never rebuilt. That, in brief, is Japan's progress in the field of atomic energy, insofar as we had ascertained when I left. For obvious reasons, no further work aimed at producing atomic energy is being permitted.

The development of our modern radar art, using microwaves, began almost exactly five years ago. Japan's most advanced radar sets are about three years behind ours in conception, and they are further behind in quality of design. Moreover, Japan could not possibly have gone into quantities of production comparable to our own even though an island empire has need for large numbers of radar outfits. Also her conception of the use of radar was quite limited. However, considering the paucity of qualified technical personnel, her development of radar was creditable and demonstrated some real ability.

We had one amusing experience while interrogating a group of 24 admirals and other naval officers on this subject. In advance, they had prepared for us a very full report, in English, on all their work in radar. This report gave the names of the personnel involved, the number of square feet of laboratory space devoted to each subject, the extent to which each laboratory was damaged by our bombing, full specifications of each radar set, and the stage of development, production, and use which had been reached on each project.

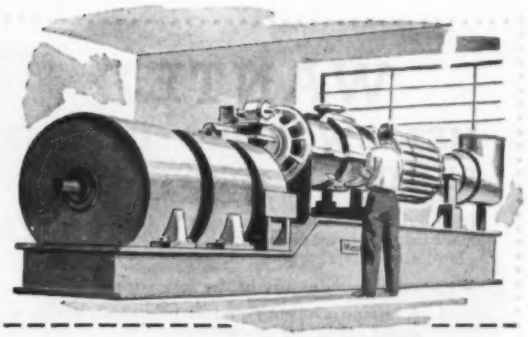
One of their sets, designed for navigational purposes in an airplane, was designated "Rotterdam Apparatus." We were interested in their use of this name for the following reason. In the winter of 1943–1944, our Eighth Air Force in England introduced very successfully the H_2S type of radar in its Pathfinder planes for leading the big bomber formations to their targets over Germany. These preliminary sets had been built in the M.I.T. Radiation Laboratory. Finally one of these Pathfinder planes was shot down, as it happened, over Rotterdam. Reports showed that the Germans were greatly excited over this radar set, which was of an entirely new type to them, and they named it the "Rotterdam Apparat."

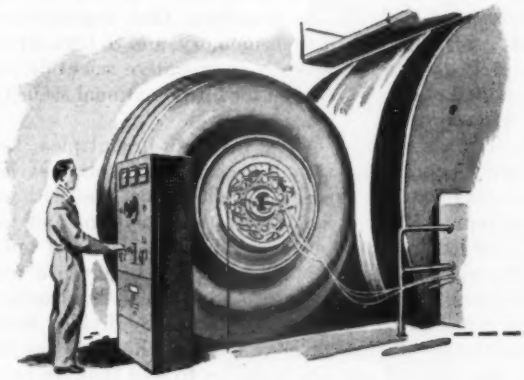
To our insistent questioning, the Japanese officers replied that they had received no plans or specifications of this apparatus from Germany and that they had designed their own Rotterdam apparatus before any German technicians reached Japan. When we pressed them still further as to how they came to use that name, they replied,

(*Concluded on page 120*)

In a laboratory a SCIENTIST experiments with a new gas turbine . . . using heat-resisting alloy blades that are far stronger, at 1100°F., than *ordinary* steel at room temperature.

. . . the name on the GAS TURBINE is Westinghouse.





On a special machine a TESTER employs a Rototrol* for smoothly accelerating a large flywheel, used in determining the wear-resisting qualities of tires and brakes—for huge air transports of the future.

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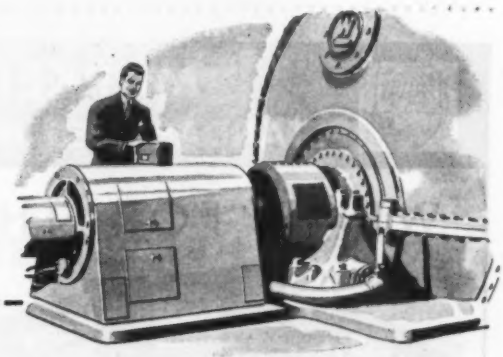

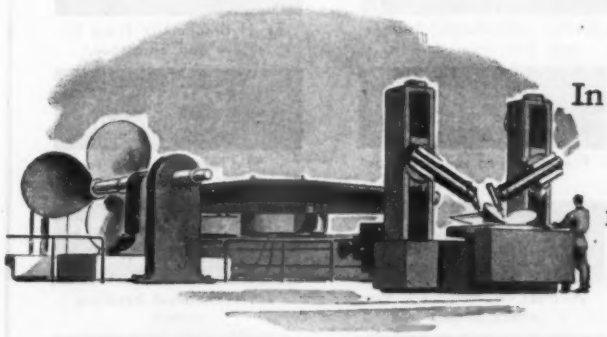

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Reply to Box Z

THE TECHNOLOGY REVIEW
Cambridge 39, Massachusetts

MISSION TO TOKYO

(Concluded from page 118)

"We understand that the Rotterdam apparatus is a German radar set something like that used by your Pathfinders. We were told about it in general terms by wireless from Germany." When we told them the true inside story of the Rotterdam apparatus, they had a good laugh on themselves.

As I conclude this rambling account of my mission to Tokyo, I am still one hour out from San Francisco and the good old U. S. A., and the C-54 is humming along on schedule. My companions of the mission are staying in Japan several weeks more to finish our assignment. I return to try to help M.I.T. in its very big job of reconversion into a peacetime educational institution, to assist my colleagues of O.S.R.D. to transform that organization quickly into only a strenuous memory, and to transfer to new permanent auspices such co-operative scientific research as should be carried on for future national security and welfare.

For one thing only I would make an urgent plea. Let us give General MacArthur a chance to work out his present difficult problems with full support and without interference. He has the feel of the situation, and his program has thus far succeeded beyond the most optimistic expectation. I hope that he may be given a free hand for at least a few months more because the situation is too complicated to be safely handled by divided management or conflicting policies. If we do this, I do not believe that we will one day wake up to find that we have lost the peace in Japan.

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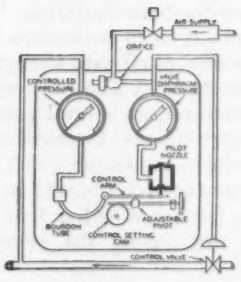

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THE INSTITUTE GAZETTE

(Continued from page 112)

Stimulation

OPENING the new season, the 246th meeting of the Alumni Council, held on October 29 with A. Warren Norton, '21, President, in the chair, probably established a record attendance with 157 members and guests present. So large was the attendance at this stimulating meeting that some who could not find tables in Pritchett Hall were served in the adjoining Silver Room and joined the larger group for the business portion of the meeting — and a great amount of varied business was transacted. Introduced as new class representatives were Roderick L. Harris for the Class of 10–44 and Thomas A. Hewson for the Class of 1945. Undergraduate class presidents, Herbert J. Hansell, 2–46, Eugene M. Gettal, 10–46, and Robert W. Hanpeter, 2–47, were announced. Eighteen new club representatives and 25 alternates were named. Faculty members appointed during the year and introduced at the meeting included: Arthur T. Ippen, Associate Professor, and Clair N. Sawyer, Associate Professor, Department of Civil and Sanitary Engineering; *Professor Jacob P. Den Hartog and *Prescott A. Smith, '35, Assistant Professor, Department of Mechanical Engineering; *Roland B. Greeley, Assistant Professor, and *Homer Hoyt, Associate Professor, School of Architecture and Planning; Ivan A. Getting, '33, Associate Professor, *Harold I. Tarpley, Associate Professor, and *Godfrey T. Coate, '42, Assistant Professor, Department of Electrical Engineering; Professor William L. Campbell, '15, Department of Food Technology; *Richard H. Bolt, Assistant Professor, Department of Physics; Professor Lybrand P. Smith (U.S.N., retired), Department of Naval Architecture and Marine Engineering; Professor Kurt Lewin, Department of Economics and Social Science; *Major Alvin J. Brodeur, Assistant Professor, and Captain Hanssen Schenker, Assistant Professor, Department of Military Science and Tactics; and Professor William N. Locke, Department of Modern Languages.

Reports of officers and committees constituted the business portion of the meeting. Plans are under way for revival of the customary reunion in the Great Court in June, which will have no relation to graduation exercises since Alumni Day will be celebrated with the graduating Class of 2–46 on February 23, 1946. The June celebration will provide the first opportunity in several years for resuming customary five-year reunions. A symposium in the forenoon, a grand luncheon in the Great Court at noon, and an Alumni Banquet at the Hotel Statler in the evening, with the afternoon left more or less free for individual social activities, are among the events being planned.

Frederick Bernard, '17, chairman of the committee to nominate representatives of local associations, stated that the committee had adopted the policy of nominating younger men to fill vacancies and had accumulated a sizeable list of potential candidates. Mr. Bernard also proposed changes in representatives for local associations and moved the formal election of those nominated. The motion was voted affirmatively. The committee's policy was

(Continued on page 124)

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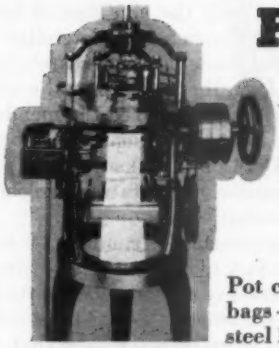

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THE INSTITUTE GAZETTE

(*Continued from page 122*)

inspired by the desire to open new opportunities for younger Alumni, but it is desired to retain the experience of the older men being replaced, who will therefore be continued as regular guests at meetings of the Alumni Council.

At the conclusion of the business portion of the meeting, President Norton introduced C. Frank Allen, '72, as the oldest member present and called upon the youngest member, Thomas A. Hewson, 6–45.

Next to be introduced was President Compton, who spoke on "Mission to Tokyo." The major portion of Dr. Compton's talk is included elsewhere in this issue, but his extemporaneous remarks included a number of personal anecdotes not recorded in the written article. One of these concerned a young Japanese naval officer who spoke excellent English and served as an interpreter. It turned out that this officer had attended the Institute shortly before the war with Japan.

Edward L. Moreland, '07, Dean of Engineering, and Dr. Compton obtained leaves of absence from the Institute for the duration and for six months, respectively. The sudden termination of the war permitted Dr. Compton to serve for the duration, while it appears that Dean Moreland's service will be for six months.

The surrender of the Japanese made it necessary to organize a scientific mission with the objective of locating laboratories and scientific personnel to determine what progress the Japanese had made in war research. In this project, alumni records from the Institute and a number of other educational institutions enabled the members of Dr. Compton's group to locate key scientific personnel in Japan, some of whom Dr. Compton had known personally. Co-operation of Japanese scientists was wholehearted and made the task somewhat easier.

Japanese scientists criticized the conduct of Japan's war and particularly the lack of co-operation between the army and navy. Much jealousy existed between these two services, and both held scientists in distrust not only because their training was usually better than that of the men in Japan's armed forces but also because scientists had travelled and knew Japan's comparative economic and military position quite well. There was a total lack of co-ordination between the work of one group of scientists and that of another, largely because of the suspicions and

(*Continued on page 126*)

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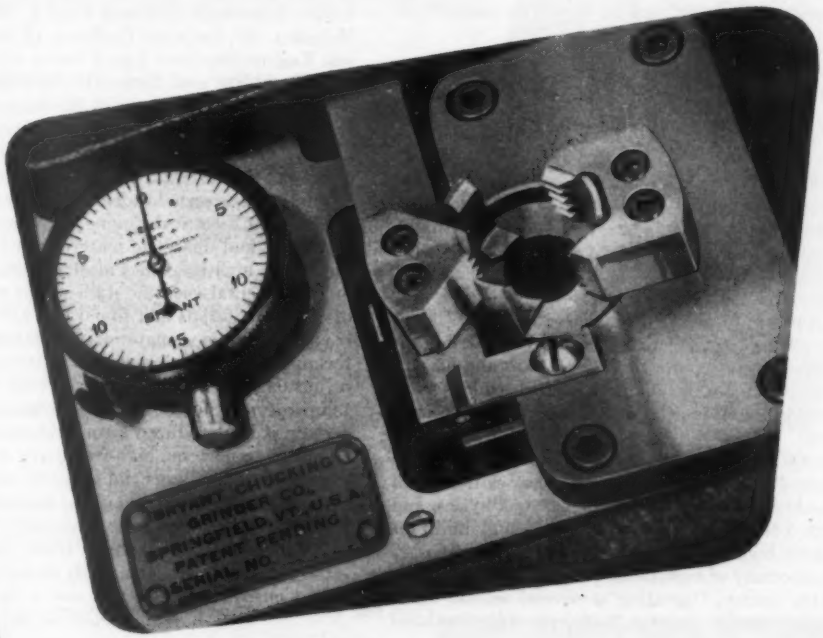

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THE INSTITUTE GAZETTE

(*Continued from page 124*)

mistrust with which military personnel regarded scientifically trained personnel. Not much evidence could be found that the Japanese had made any progress in the utilization of atomic energy because their early calculations had been misinterpreted. A more detailed treatment of President Compton's report will be found on page 99 of this issue.

President's Report

(*Continued from page 109*)

The Cyclotron. Under Professor Robley D. Evans, the M.I.T. cyclotron was one of the few in America to remain in operation. The staffs of most of the others were diverted to the development of radar and the atomic bomb. Operated on day-and-night shifts, this instrument provided radioactive tracer materials for a wide variety of war projects in metallurgy, medicine, and chemical warfare. Most significant was the use of such materials in the development of methods for preserving whole blood and standardizing the product. In this important contribution to the great blood-donor program, Professor Evans and his colleagues were part of a team including medical specialists from Harvard University, the Massachusetts General Hospital, and other institutions.

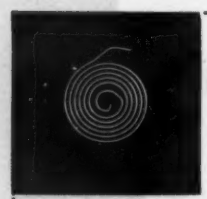
The High-Voltage Laboratory. Headed by Robert J. Van de Graaff, Associate Professor of Physics, in association with William W. Buechner, '35, Assistant Professor of Physics, and others, the High-Voltage Laboratory designed and built for the Navy five superhigh-voltage x-ray outfits for examination of castings and especially of munitions, both our own and those captured from the enemy. Operating at several million volts, with literally a pin-point focal spot, reliable and easily regulated over a wide range of operating conditions, these instruments proved exceedingly effective and won high praise from the naval officer in charge, himself a distinguished scientist and expert in this field. They represent a peak of achievement in securing penetrating x-ray pictures of sharp definition and high resolving power both in angle and in depth.

Fuel Research. The most significant work in fuels was the investigation of the thermodynamic properties and combustion characteristics of new fuels designed for special purposes. The work was part of a large program of development of such fuels, in which a number of industrial, university, and service laboratories co-operated. Professor Hoyt C. Hottel, '24, and Glenn C. Williams, '42, Assistant Professor, of the Department of Chemical Engineering have joined forces with Professor C. Richard Soderberg, '20, and Ernest P. Neumann, '38, Assistant Professor, of the Department of Mechanical Engineering in working on fuels and related problems of combustion.

The Laboratory for Insulation Research. One of the busiest groups at the Institute has been the staff of the Laboratory for Insulation Research, headed by Arthur R. von Hippel, Associate Professor of Electrical Engineering, and devoted to the study of insulating and dielectric materials and especially their characteristics in high-frequency electric fields. In addition to carrying on fundamental scientific studies, this laboratory developed new dielectric materials and found out how to secure the optimum results from older materials. It developed a complete set of techniques and equipment for performing all significant tests on insulating materials under a wide variety of conditions of temperature, moisture, and composition. As a co-operative service, it has produced a comprehensive and widely circulated summary report on high-frequency insulating materials submitted by many industrial concerns and other agencies.

Liquid Oxygen. Submarines, aircraft crews, hospitals, and welders need oxygen. The customary shipment of compressed or liquefied oxygen in tanks from production plants in large cities does not serve the needs at sea or in distant theaters of war. Consequently this war saw a remarkable advance in the

(*Continued on page 128*)



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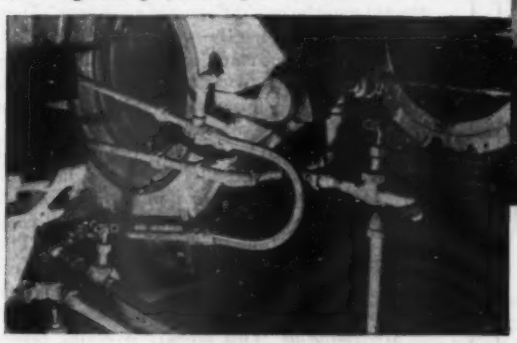

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THE INSTITUTE GAZETTE

(*Continued from page 126*)

efficiency of oxygen production and in transportation of it by lightweight portable units. To these developments, Professor Frederick G. Keyes of the Department of Chemistry and Samuel C. Collins, Associate Professor in the Department of Mechanical Engineering, made very important contributions.

Here again, war developments may lead to important industrial applications, and we are prepared both in the Department of Chemistry and in the Department of Mechanical Engineering to take advantage of the new art developed during the war. In the latter Department, for example, we are establishing a program in cryogenic engineering under the direction of Professor Collins.

The C. W. S. Development Laboratory. The Chemical Warfare Service Development Laboratory represents a different type of M.I.T. contribution to the war effort.[1] With its Edgewood Arsenal greatly overcrowded, the C. W. S. urgently needed another laboratory for research and development work. It learned that M.I.T. had architects' plans already drawn for a new chemical engineering laboratory, for which the plans to raise funds had been interrupted by the war. At the request of the C. W. S., the Institute proceeded to build this laboratory at its own expense and then to turn it over to the C. W. S. for operation under a contract providing for maintenance expenses plus a fee for use and special services. The net result was that the C. W. S. was thereby enabled to expand its research activities, while the Institute was justified in proceeding with the construction of the building, soon to be freed for our own use.

The Wind Tunnel. All through the war the Wright Brothers Wind Tunnel has been operating on a two-shift basis in the testing of models of military airplanes in co-operation with the principal aircraft manufacturers. The continuous use of the tunnel on confidential work has not permitted use of it as a laboratory for student instruction. However, the tunnel has trained many engineers for the design and operation of other wind tunnels, such as those at the Boeing Aircraft Company and at the research division of the United Aircraft Corporation. From the latter company nine engineers were sent to the Wright Brothers Wind Tunnel during the war for six months' training periods. With the ending of the war, the tunnel will be used extensively for instruction and thesis work of both our undergraduate and our graduate students.

The Center of Analysis. A similar service function has been rendered all through the war by the group which operates both the old and the new differential analyzers.[2] They have computed the range tables for the new naval guns and ammunition as well as performed many other computational services for various war agencies. Antenna patterns, characteristics of wave propagation and absorption, and determination of statistical correlation coefficients are some of the other computing jobs quickly performed by the various automatic calculating devices developed and operated by this group, headed by Richard Taylor, '34, Assistant Professor, in the absence of Samuel H. Caldwell, '25, Associate Professor of Electrical Engineering, and by their colleagues from several departments. The war gave great impetus to further developments in machine calculation, and as a consequence we have opportunities in this field of a magnitude beyond anything we have yet undertaken.

Miscellaneous. This already overlong report omits a great many significant contributions to the war by the M.I.T. staff and laboratories. Development and evaluation of methods of

(*Concluded on page 130*)

[1] An illustrated report on the C. W. S. Development Laboratory is contained on pages 103 to 106 of this issue.

[2] The differential analyzer was described under the title, "Educated Machinery," by Samuel H. Caldwell, on pages 31 to 34 of the November, 1945, issue of The Review.

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THE INSTITUTE GAZETTE

(*Concluded from page 128*)

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WHERE IS THE LONG HAIR?

(*Concluded from page 108*)

period of the landings on Sicily and Italy. These are but a few instances; there are many others as striking and as instructive.

What is the lesson to be drawn from these examples? It is not that the pure scientist should forthwith desert the laboratory and become an engineer, an administrator, or a tactician. Who then would do the research? There will not be enough scientists in the postwar world to carry on the research necessary to keep this country wealthy, happy, and prepared, and it certainly would not be wise for many of them to migrate to other fields. Pure scientists have no monopoly on administrative ability or on practical common sense. All that these examples point out is that they are not deficient in these qualities.

What does seem to be indicated, however, is that in this present era of science the jobs of engineering, administration, and military planning require a broad scientific background of knowledge which many engineers, administrators, and military officers have not had and that it was easier in some cases for the scientists to pick up the special tricks of application than it was for the other men to pick up the scientific background in a hurry. The moral to be drawn concerning the training of engineers, industrial and governmental administrators, and regular military officers is obvious. The experience of this war has been that a scientific approach to a practical problem produces rich dividends and that scientific training cannot be quickly acquired.

Another lesson might be mentioned here. There are immense unexplored possibilities of applying scientific methods to the improvement of operations of peace in a manner analogous to the techniques used by operations research groups in improving operations of war. Any operational research worker can see as many chances for improving railroad operations, for instance, as there were for improving strategic bombing operations. Merchandising and municipal government seem to be other obvious fields for the application of these scientific techniques.

Still another lesson is even now being pondered by our legislative bodies. Rapid advance of science and its applications takes place only where there is no coercion of activity and when there is free interchange of ideas on an international scale. The more rapidly national restrictions and suspicions can be eliminated, the faster can scientific method play its part in waging peace.

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THE TREND OF AFFAIRS

(*Continued from page 97*)

From the elementary nature of the four true taste sensations, it is apparent that the limitless delicate nuances of flavor which contribute so importantly to human enjoyment must be credited largely to the odor component of flavor. The complexity of odors is borne out by the limited success of all attempts so far to classify odor sensations. In the absence of satisfactory nomenclature, odors are usually described by likening them to known substances, saying "that smells like onions" or "this has a fishy odor" and so on. Odors, like tastes, have reciprocally additive and subtractive effects and also enter into synergistic relationships with the true taste sensations. Thus we like to experience the "flavor" of vanilla, which is purely an odor, in company with the taste of sweet. Salt on grapefruit not only replaces sugar for avoirdupois-conscious consumers but also is favored by others because they feel that salt enhances the characteristic odor-flavor of this fruit. Chefs commonly use small amounts of sugar to accentuate flavors of savory dishes.

The four true tastes are liked by almost everyone, provided they are experienced in suitable concentrations and combinations. Even sour and bitter, which at first blush have unpleasant connotations, are relished in a tangy lemonade or bitter almond, respectively. In contrast, the odor component of flavor, with its many and as yet not satisfactorily classified ramifications, offers perhaps as wide a field for individual preferences as does the sensation of color. A recent experimental survey of odor preferences showed, first of all, that individual likes and dislikes varied greatly, underlining the necessity for manufacturers concerned with flavors or odors to use large and representative groups of subjects in testing acceptability of proposed formulas. This study, using one of the arbitrary odor classifications just mentioned, found that a test group, including both sexes and a wide range of ages, had majority preferences for the "flowery" odors, rose and violet; the "fruity" odors, orange, lemon, pineapple, peach, apple, strawberry, and raspberry; the "spicy" odors, cinnamon, chocolate, vanilla, wintergreen, and peppermint; the "resinous" odors, balsam and pine; and the "burnt" odor, coffee. On the other hand, majority aversions were recorded for the "fruity" odors, olive oil and vinegar, and the "putrid" odors, onion, garlic, sauerkraut, fish, and lard.

(*Concluded on page 134*)

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THE TREND OF AFFAIRS

(*Concluded from page 132*)

A feature of this study which is valuable to those wishing to design products for flavor or odor appeal to specific segments of the population is a tabulation of findings by sex and age classifications. Females showed a marked differential liking for certain of the fruity and spicy odors. With the exception of a male preference for the odor of smoked meats, the remaining odor likes were well balanced between the sexes. In the age comparison, older people showed relative preferences for the odors of violet, honey, smoked meats, and onion. The youngsters, contrariwise, favored chocolate and sarsaparilla. One might theorize here on the effect of training upon flavor preferences; perhaps the liking for such a highly artificial flavor as that of smoked meats must be learned. In this connection, it is also interesting to recall a previously advanced suggestion that some juvenile feeding problems may be due to a relatively keener flavor sense possessed by youngsters. The dulling effect upon flavor perception of the adult practice of tobacco smoking and continued consumption of highly seasoned foods has been established.

The study dealt with each odor separately. Obviously all of the odors disliked alone are highly prized as components, in small concentrations, of the flavor of prepared dishes. The fact that a small degree of rancidity is acknowledged to be a normal and desirable part of the flavor of peanut butter is striking proof of the ancillary value of flavors unpleasant in themselves.

Electronic Warfare

FOLLOWING a statement by Vannevar Bush, '16, that "the new eyes which radar has supplied can sometimes be blinded by new scientific developments," a report released by the Joint Board on Scientific Information Policy, entitled *Electronic Warfare — A Report on Radar Countermeasures*, outlines developments which have been made to minimize the effectiveness of enemy radar.

The radar countermeasures were recently demonstrated at the Radio Research Laboratory, operated during the war at Harvard University under the direction of Frederick E. Terman, '24.

Radar methods have four fundamental weaknesses which have been successfully exploited in outwitting German and Japanese radar developments. A radar station employs a powerful radio transmitter, signals from which can be heard at a considerable distance beyond that for which the system is effective for locating ships or aircraft. The location of radar stations, like that of any radio transmitter can be determined by means of radio direction finders. Since the radar signal reflected from most targets is very weak, a low-power transmitter may be employed to transmit a jamming signal to obliterate true radar indications. Such transmitters may be located at the target whose position is desired or at a convenient ground station. Radar systems are unable to distinguish readily between actual targets and free-falling strips of tin foil, particularly when cut into strips of suitable length.

The first two disadvantages have been employed in locating enemy radar stations by reconnaissance planes and ground stations operating at distances beyond that for which their presence can be detected by radar.

Jamming of, or interfering with, radar signals by transmitting a blanketing signal of "noise" has been used as a powerful method of making enemy radar detection methods ineffective. A number of jamming stations were established secretly in France before the Normandy invasion and proved of great assistance in confusing the Germans during actual invasion operations.

Finally, the use of strips of metal foil dropped from planes has been used to provide false echo signals from which the enemy would gather erroneous or useless information. Rolls of tin-foil strip, 400 feet long, or bundles of folded tin-foil strips, half a wavelength long, dropped from planes, produce an effective "smoke screen" which made enemy radar of little value. Each two-ounce bundle of tin foil produced about the same signal as three bombers.

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